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CONTENTS

The Vascular Plants of Southwestern Georgia	Robert F. Thorne	257
Supplement to a Treatise on the North American Ranunculi	Lyman Benson	328
Studies in and near Michigan's Tension Zone: I. A Northward Extension for the Range of <i>Ulmus Thomasi</i> Sarg	Jack C. Elliott	370
Observations on Petiolar Branching and Foliage of an American <i>Botryopteris</i>	Theodore Delevoryas and Jeanne Morgan	374
A Remarkable New Mammal From the Lower Chadron of Nebraska	Harold J. Cook	388
Some Observations on Moose in Yellowstone Park	John F. McMillan	392
Aberrant Coloration in <i>Tadarida Mexicana</i>	Bryan P. Glass	400
An Ecological Study of the Waterfowl of the Pot-Holes Area, Grant County, Washington	Stanley W. Harris	403
Ovarian Egg Complements and Nests of the Two-Lined Salamander, <i>Eurycea</i> <i>b. bislineata</i> X <i>cirrigera</i> , From Southeastern Virginia	John T. Wood	433
Two New Species and a New Variety in the Genus <i>Arachnophroctonus</i> (Hymenoptera: <i>Psammocharidae</i>) With Photomicrographs of the Genitalia and Subgenital Plate for the Genus and for Several Other Species	R. R. Dreisbach	437
The Ant Larvae of the Myrmicine Tribes <i>Meranoplini</i> , <i>Ochetomyrmicini</i> and <i>Tetramoriini</i>	George C. and Jeanette Wheeler	443
<i>Drosophilidae</i> in New York and New Jersey	Max Levitan	453
<i>Haemopsis kingi</i> , New Species (Annelida, Hirudinea)	Carol K. Mathers	460
A Catalogue of the Protozoa and Helminths of North American Rodents. II. Cestoda	David J. Doran	469
Contributions to the Life Cycles of Gorgoderid Trematodes	William H. Coil	481
Sponge Spicules From the Lower Mississippian of Indiana and Kentucky	R. C. Gutschick	501
Notes and Discussion		
Sizes of Wood Cuttings Handled by Beavers	Albert R. Shadle	510
A Bloom of Nauplius Larvae	Ralph W. Dexter	512

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The Vascular Plants of Southwestern Georgia*

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CONTENTS

Physical characteristics of the area.....	258	Settlement and exploitation by man....	265
Location	258	Botanical collecting in southwestern Georgia	265
Physiography	258	Annotated catalogue of vascular plants	266
Geological history	260	Explanation of catalogue	266
Climate	261	Statistical summary	325
Soils	262	References	326
Vegetation	262		
Floristic elements	264		

The survey leading to the preparation of this annotated catalogue was begun in the summer of 1946 when the writer was doing field work for the Communicable Disease Center of the United States Public Health Service at Emory University Field Station near Newton, Georgia. While establishing an herbarium at the Field Station at that time, the writer collected over 800 numbers of vascular plants, mostly in the Field Station vicinity.

Many factors contributed to the writer's decision to continue and to expand the survey of the vascular plants of southwestern Georgia. Among them were the paucity of plant collections that had been made in this corner of Georgia, the need for a complete catalogue of the flowering plants of the Field Station area, the proximity of inland plants in the Red Hills and coastal plants on the Dougherty Plain, and the excellent facilities for field investigation available at Emory University Field Station. This more intensive survey was made during the growing season of 1947 and on subsequent collecting trips in 1948 and

* Contribution based upon field work done in southern Georgia under the joint auspices of Emory University Field Station, Newton, Georgia and Cornell University, Ithaca, New York. The writer is indebted to Major M. H. Goodwin, Jr., Director of Emory University Field Station, and to Professor W. C. Muenschner of Cornell University for their help and advice during this study.

1949. In this period about 7000 additional numbers, totaling more than 17,000 sheets, were collected and nearly 25,000 miles were traveled in the area. Field notes were taken and quadrat studies were made in the different plant communities to obtain precise information on the distribution and habitats of plants in southwestern Georgia. Some of the results of this work have been published (Thorne 1949a, 1951) or submitted as a thesis (Thorne 1949b) to the Graduate School of Cornell University, Ithaca, New York.

PHYSICAL CHARACTERISTICS OF THE AREA

Location.—The portion of Georgia surveyed botanically by the writer is located on the Gulf Coastal Plain in the southwestern corner of the state. Covering approximately 5000 square miles, it is a wedge-shaped area bounded on the west by the Chattahoochee River, which there forms the boundary between Georgia and western Florida and Georgia and Alabama, at the apex by the Florida State line, on the southeast and east by a prominent solution escarpment (or cuesta) and the Flint River, and on the north by the northern boundaries of Stewart, Webster, and Sumter counties. Included in the area are all of Baker, Calhoun, Clay, Dougherty, Early, Lee, Miller, Quitman, Randolph, Seminole, Stewart, Sumter, Terrell, and Webster, and parts of Decatur, Grady, Mitchell, and Worth counties (See map of southwestern Georgia). The approximate coordinates at the farthest points are $30^{\circ} 42' N$ on the south, $32^{\circ} 13' N$ on the north, $83^{\circ} 56' W$ on the east, and $85^{\circ} 08' W$ on the west. At the maximum distances the area is 101 miles long and 71 miles wide. Elevations vary from 50 feet above sea level at the mouth of the Flint River to 691 feet at Brooklyn in Stewart County near the northern boundary of the area.

Physiography.—The region is unequally divided into two physiographic units—a relatively narrow band of submaturely dissected hilly upland (the Red Hills) in the northwestern corner and an extensive low, flat or undulating solution plain (the Dougherty Plain) covering the rest.

The Red Hills belt (Fenneman 1938), in Georgia geology usually included in the sandy Fall Line Hills which border it on the north and northwest, is a level to rolling plateau dissected by deep, steep-sided valleys and ravines. The flat-topped divides, more or less accordant in level, attain elevations of 400 to 600 or more feet above sea-level and in the watershed of the Chattahoochee River often stand 100 feet above the valley floors. The short, lateral streams running into the Chattahoochee River in Clay and Early counties flow through deep gorges for two or three miles until they reach the river. The river on its left, or east, bank is flanked by the upland, which forms a high, steep bluff. In some places, as at Fort Gaines, the river flows at the foot of the bluff; in others, as west of Hilton, a high terrace separates the river from the bluff. Toward the Flint River the topography of the Red Hills becomes less steep, and the upland there is characterized by gentle slopes and wide, flat-bottomed valleys.

Roughly the area included in this hilly region covers most of Clay and Webster, much of Randolph, Quitman, and Stewart, portions of Terrell and

Sumter counties, and the northwestern corner of Early County with an extension in the form of bluffs along the Chattahoochee River to Saffold.

The broad, gently undulating Dougherty Plain reaches from this hilly upland southeastward beyond the Flint River to the retreating escarpment at the edge of the Tifton Upland. The low elevation of the plain, mostly be-



Fig. 1.—Map of southwestern Georgia

tween 130 and 250 feet, contrasts markedly with the greater elevation of the Red Hills on the northwest and the Tifton Upland on the southeast. The monotony of the plain is broken by low ridges, numerous shallow lime-sinks ranging in size from less than one to many hundred acres, a few permanent ponds, and the flat-bottomed valleys of the larger streams. The coarse drainage pattern, sinks, and numerous springs along the streams point to at least partial solution origin of the plain. It is drained largely by the Flint River and its tributaries.

Included within this low-lying plain are all of Lee, Calhoun, Dougherty, Baker, Miller, and Seminole, most of Sumter, Terrell, Early, Mitchell, and Decatur, and part of Randolph and Grady counties.

The escarpment bordering the Dougherty Plain has been taken as the southeastern boundary of the area surveyed. The Tifton Upland, or Altamaha Grit region, to the southeast and east has been studied botanically by Harper (1906). The escarpment, or cuesta, is most conspicuous in Decatur County where its upper edge stands 150 to 200 feet above the plain to the north and west. It is easily observed also in Grady and Mitchell counties but becomes less evident farther north. It is of particular interest because of the steep-heads, springs, sinks, and disappearing streams found along it.

Geological History.—The geological history of the present Gulf Coastal Plain of Georgia began in the early Upper Cretaceous when the Tuscaloosa formation was deposited on the peneplaned crystalline basement of the Atlantic Plain (Fall Zone peneplain). Since that time its history has been one of repeated submergence by the sea as evidenced by marine shells in the many later formations and emergence from the sea as indicated by unconformities marking erosion intervals between the formations. Volcanic rocks are absent and there is no evidence of major folding or faulting (Cooke 1943). That there has been intermittent regional uplift interrupted by resubmergence is evidenced by the offlap and onlap of formations and by the fact that the oldest beds have progressively steeper dips. As the innermost portion of the Coastal Plain has experienced the greatest uplift and is raised highest, it has been subjected to deeper erosion and is much more dissected than the later formations nearer the sea. Probably there has been peneplanation of the Cretaceous and Eocene beds at least once since their deposition. The inner portion of the Gulf Coastal Plain of Georgia thus is possibly undergoing its second or third cycle of erosion while the Pleistocene formations toward the coast are undergoing their first. The limestone-floored Dougherty Plain has apparently been lowered by a combination of subsurface solution and fluvial erosion by the Flint River and other streams.

Exposed above the Tuscaloosa formation on the inner Gulf Coastal Plain are five different formations of Upper Cretaceous age (the Eutaw, Blufftown, Cusseta, Ripley, and Providence), composed mostly of sands of marine origin and separated by unconformities. Coastward from these are encountered successively exposures of the Paleocene Clayton formation (typically a white sandy limestone), the Eocene Wilcox and Claiborne groups (sand, clay, marl, limestone, sandstone, and claystone) and Ocala limestone, and the Oligocene Flint River formation (mostly limestone), which overlaps the Eocene formations. Each of these units represent a resubmergence under the sea and a later

period of emergence when erosion brought about the unconformities that exist now between the beds.

The Oligocene submergence is the last major invasion of the area by the sea that is well-documented by stratigraphic evidence. Miocene beds (Tampa limestone and Hawthorn formation) outcrop only along the escarpment marking the inner edge of the Tifton Upland, but it is probable that the escarpment has retreated from a position farther west. During the Pleistocene submergences some of the area may have been covered by the sea. Cooke (1939) maps the generalized and partly conjectural shorelines of the early Pleistocene seas, four of which possibly invaded the area following up the Chattahoochee and Flint river valleys. The Brandywine and Coharie seas are represented as reaching far up the valleys, whereas the Sunderland and Wicomico seas are indicated to cover only the southern tip of the area. The Pleistocene deposits, especially along the rivers, however, are perhaps of non-marine origin. The terraces along the two rivers may correlate with these early Pleistocene shorelines. The oscillation of the Pleistocene seas was due, according to glaciologists, to the withdrawal of great quantities of water from the seas during the formation of the continental ice caps during the four main Pleistocene ice ages, and to the return of these waters to the sea as the ice caps wasted back at the end of each ice age. The progressive lowering of sea level at each return of the sea is inferred to be due to regional uplift of the land.

Portions of southwestern Georgia may not have been available for the occupation of plants until the Sangamon interglacial stage, i.e., the one between the third and last advance of the ice sheets. The hilly, dissected region to the north, especially the Red Hills, may have been open, however, to plant invasion since the close of the Oligocene when the Vicksburg sea withdrew leaving the Flint River formation overlapping the early Eocene deposits. In the earliest formation in the region, the Tuscaloosa, some of the genera represented by fossil leaves, such as *Aralia*, *Juglans*, *Magnolia*, *Salix*, and *Torreya*, are still represented in southern Georgia by indigenous species.

Climate.—The climate of southwestern Georgia is oceanic, as might be expected from its proximity to the Gulf of Mexico and the Atlantic Ocean. The summers are long and warm and the winters short and mild, with no prolonged periods of extreme heat or severe cold. At times during the summer the heat during the day is oppressive, but the nights are usually comfortable. The average daily temperature (F) in July ranges from 80.6° (Lumpkin) to 82.2° (Albany). The maximum temperature recorded in the area is 109° (Bainbridge), the minimum -6° (Americus). The average daily temperature in January ranges from 48.2° (Morgan) to 52.4° (Bainbridge). The coldest weather occurs as brief cold snaps followed usually by several warm days. Snow seldom falls and only occasionally thin ice forms.

The normal growing season, or frost-free period, lasts from 233 days at Lumpkin (altitude 515 feet) in the Red Hills to 250 days at Bainbridge (altitude 119 feet) on the Dougherty Plain. The average date of the last killing frost in the spring is March 21 at Lumpkin and March 10 at Bainbridge, and of the first killing frost in the fall is November 9 at Lumpkin and November 15 at Bainbridge. Frost, however, has been reported as late as April 26 and as early as October 21.

The average annual precipitation is 47.67 inches at Lumpkin, 49.31 at Americus, 50.44° at Bainbridge, 51.96° at Fort Gaines, and 53.81° at Blakely. This rainfall is usually well distributed throughout the year, with the heaviest rainfall in July and August and the lightest in October and November. In 1947 rainfall was particularly heavy (67.62 inches at Albany, 68.51 at Bainbridge, and 72.63 at Emory University Field Station, 11 miles southwest of Newton), the southern third of the state having an average of 66.53 inches, which exceeded all previous records for the area (U. S. Dept. Comm., Weather Bureau, 1947).

Soils.—The soils of southwestern Georgia are red and yellow podzolic soils modified by laterization. They are mostly low in mineral nutrients and organic matter, strongly leached, and acid in reaction. Two principal soil areas are present between the escarpment and the Chattahoochee River—the Greenville-Magnolia and Norfolk-Ruston areas (See Yearbook of Agriculture 1938).

The Red Hills and higher portions of the Dougherty Plain fall within the Greenville-Magnolia area of red soils. Predominant on the upland areas are the loamy sands, sandy loams, and clay loams of the Greenville and Blakely series, characteristically brownish to red on the surface with red subsoils. Associated with these are soils of the Orangeburg, Ruston, Norfolk, Cuthbert, and Susquehanna series. These soils are derived from limestones, sandy clays, and clays of Lower Eocene and Oligocene formations. Where not excessively drained or subject to erosion, they are the most fertile soils in southwestern Georgia. Their principal crops are peanuts, tobacco, cotton, corn, pecans, peaches, oats, soybeans, and velvet beans.

The outer portion of the Dougherty Plain and the southern part of the Fall Line Hills come within the area of Norfolk-Ruston soils. These soils are mostly sandy, light-colored, and acid. Predominant on the level or undulating plain are the well drained to excessively drained sands, coarse sands, and loamy sands of the Norfolk and Tifton series, with gray surface soils and yellow, friable subsoils. Closely associated with these are soils of the Ruston and Orangeburg series. They are derived largely from unconsolidated beds of sands, sandy clays, and clays with little evidence remaining of the underlying limestones of the Ocala and Flint River formations. The principal crops are peanuts, tobacco, pecans, cotton, corn, oats, and truck crops.

Several other soil series are characteristic of the poorly drained areas, first bottoms, and second bottoms. The Grady soils are largely confined to sinks and depressions, low flat areas, and sloughs. Since these soils are poorly drained, they are not good agricultural soils. Similar are soils of the Portsmouth and Plummer series. On the first bottoms along the rivers is found Congaree silty clay loam, fertile but poorly drained and subject to overflow at high water. It mostly remains in hardwood forest. On the second bottoms, or river terraces, are developed the Cahaba, Kalmia, Amite, Leaf, Chattahoochee, and Flint series and the poorly drained Myatt soils.

VEGETATION

The southwestern corner of Georgia possesses, where not removed by man, a plant cover consisting of two more or less distinct floras whose distribution in the region is largely that of the two major physiographic units. In the Red

Hills is a flora containing a large percentage of inland plants and a vegetation more Piedmont than Coastal Plain in aspect. The vegetation of the Dougherty Plain, on the other hand, is typically Coastal Plain in composition and appearance.

The heavier-textured soils of the Red Hills, where not in cultivation, are covered on the level or rolling divides with mixed woods of *Pinus echinata* and *Pinus taeda* and hardwoods, especially *Cornus florida* and species of *Quercus* and *Carya*. On the dissected and often steep slopes is a mixture of hardwoods, including species of *Fagus*, *Magnolia*, *Quercus*, *Carya*, *Liriodendron*, *Acer*, *Tilia*, *Liquidambar*, and *Fraxinus* and some *Pinus taeda* and *P. glabra*. Mixed with such Coastal Plain plants as *Magnolia grandiflora*, *Pinus glabra*, *Rhaphidophyllum hystrix*, and *Tillandsia usneoides* are many plants not ordinarily found on the Coastal Plain (Thorne 1949a). Such species as *Smilax h. hispida*, *Castanea dentata*, *Quercus rubra*, *Q. coccinea*, *Magnolia tripetala*, *Xanthoriza simplicissima*, *Dirca palustris*, and *Cornus alternifolia*, to mention but a few of the woody plants, belong more properly to the widespread deciduous forests of eastern North America. A somewhat similar flora of deciduous hardwoods is found on the deeply dissected portions of the escarpment. About 120 species of vascular plants are restricted in southwestern Georgia largely to the rich woods of ravines and bluffs in the Red Hills and along the escarpment.

The Dougherty Plain with its sandy, acid, light-colored soils furnishes several thousand square miles of habitats suitable for the distinctive flora of the Coastal Plain. Many of the species show the same distribution in the area, one in which the plants are restricted to the Dougherty Plain or to the Dougherty Plain and the limited areas of dry, sandy soil or small bogs in the Red Hills. Such plants are typically oxaliphytes found in pinelands, barrens, sandy hammocks, cypress ponds, bogs, and sandy swamps. The list of characteristic Coastal Plain species found on the Dougherty Plain, including many which reach here their inland limit in southern Georgia such as *Pinus elliotii*, *Taxodium ascendens*, *Quercus pumila*, and *Q. virginiana*, exceeds 600 species and includes many representatives of *Panicum*, *Paspalum*, *Carex*, *Eleocharis*, *Rhynchospora*, *Scleria*, *Xyris*, *Juncus*, *Smilax*, *Quercus*, *Siphonochia*, *Sarracenia*, *Polygala*, *Ilex*, *Hypericum*, *Rhexia*, *Ludwigia*, *Eryngium*, *Sabatia*, *Asclepias*, *Gerardia*, *Utricularia*, *Cacalia*, and *Solidago*.

The distribution of the various plant communities on the Dougherty Plain is determined largely by the depth of the water table below the surface of the ground and by the soil types, predominantly sandy. Where the water table is well below the surface, as is true for most of the plain, *Pinus palustris* and several species of *Quercus* are dominant. *Pinus elliotii*, *Nyssa sylvatica biflora*, and *Taxodium ascendens* cover the poorly-drained areas where the water table, real or perched, intersects the surface. Hardwood hammock or swamp occupies the richer soils around some of the larger ponds, along the streams, and in the river bottoms.

Calciphites are not common in the leached and predominantly acid soils of southwestern Georgia. They occur for the most part only in places where the underlying, unmodified limestone comes to the surface, as along Fowltown Creek in Lee County, in the vicinity of Greer's Cave in northern Randolph County, and on the bluff overlooking the Flint River just north of the Florida State line. A few of the species apparently limited to such areas in this region

are *Asplenium resiliens*, *Pellaea atropurpurea*, *Quercus muehlenbergii*, *Arenaria patula*, *Arabis canadensis*, *Tragia cordata*, *Thaspium barbinode chapmani*, *Lithospermum tuberosum*, and *Houstonia nigricans*.

FLORISTIC ELEMENTS

At least 1540 species of vascular plants are believed to be indigenous in southwestern Georgia. Among these the endemic element, those plants limited in range to this corner of the state and adjacent areas of Florida and Alabama, is surprisingly large, comprising more than thirty species.

At least eight species are based on type specimens collected in the area surveyed, and several others (including a *Rhynchospora*, a *Scleria*, and a *Cirsium*) collected by the writer are apparently undescribed and await publication. *Fimbristylis perpusilla* Harper and *Mesadenia maxima* Harper are known only from their type localities in Sumter County, and *Bumelia thornei* Cronquist has been collected at only four stations in three counties of southwestern Georgia. *Arabis georgiana* Harper, *Lythrum curtissii* Fernald, and *Cacalia sulcata* Fernald have ranges that seem to be restricted at most to Georgia, Alabama, and northern Florida. *Paronychia riparia* Small and *Scirpus fontinalis* Harper are wider ranging species.

Although not described from types collected in the area surveyed, the following species have been reported only from southwestern Georgia and western or northern Florida: *Torreya taxifolia* Arn., *Sagittaria isoetiformis* J. G. Smith, *Chloris floridana* Chapm., *Sporobolus floridanus* Chapm., *Veratrum intermedium* Chapm., *Salix floridana* Chapm., *Nuphar orbiculata* (Small) Standley, *Ludwigia spathulata* T. & G., *Angelica dentata* (Chapm.) C. & R., *Amsonia rigida* Shuttlw., *Aster eryngiifolius* T. & G., *Cacalia diversifolia* T. & G., and *Rudbeckia mohrii* A. Gray. Reported only from southwestern Georgia and southern Alabama are *Rhododendron prunifolium* (Small) Millais and *Matalea alabamensis* (Vail) Woodson. Apparently restricted to southern Georgia, northern Florida, and southern Alabama are *Sagittaria chapmanii* (J. G. Smith) C. Mohr, *Uvularia floridana* Chapm., *Siphonochia interior* (Small) Core, *S. rugelii* Chapm., *Euphorbia floridana* Chapm., *Myriophyllum laxum* Shuttlw., *Cornus asperifolia* Michx., *Pieris phillyreifolius* (Hook.) DC., *Phlox floridana* Benth., *Brickellia cordifolia* Ell., *Chrysopsis oligantha* Chapm., and *Vernonia ovalifolia* T. & G. Two other noteworthy species, *Croomia pauciflora* (Nutt.) Torr. and *Silene baldwynii* Nutt. range somewhat farther north and above the Fall Line in Georgia and Alabama. These endemics are mostly well-defined species clearly separated in morphological characteristics and often in space from their nearest relatives.

In addition to these restricted endemics, nearly 135 species found in southwestern Georgia are limited to the southeastern Coastal Plain. Approximately 380 other Coastal Plain species are wider-ranging, including at least 90 reported from tropical America and several species known from as far north as New England. About 140 species have a general southeastern range, 560 a wide range in eastern North America, 90 an even wider range in eastern and western North America, 75 a wide range in North America and tropical America, and 37 a distribution including portions of both the New World and Old World. Vascular plants which reach a limit of their known range in southwestern Georgia include 60 species with a wide range to the north and west, 39 species

of the Gulf Coastal Plain, 13 tropical species, 6 western species, and 5 species of the Atlantic Coastal Plain. Many species distributed widely on the outer Coastal Plain reach here their inland limit in southern Georgia.

Approximately 210 species of vascular plants are thought to be naturalized in the area. As closely as can be determined from information available, 21 of these are of North American origin, 98 are from temperate areas other than North America, 88 are from the tropics, and 3 are semi-cosmopolitan weeds.

SETTLEMENT AND EXPLOITATION BY MAN

The date of man's first arrival in southwestern Georgia cannot be determined, but the Kolomoki Mounds in northern Early County furnish evidence of a considerable prehistoric population center in the area. Southwestern Georgia was the home at different times of several Indian tribes of different linguistic stocks, and must have had a sizeable Indian population (Swanton 1946). The predominantly Indian origin of the names of streams in southern Georgia is the main heritage bequeathed by the Indians to the present residents.

The written history of southwestern Georgia began in 1540 when the De Soto expedition marched through the heart of the region. De Soto and his men probably spent less than a month in the area. In 1633 missionary work was begun by the Spaniards among the Apalachee Indians to the south in Florida, and perhaps some of the missionaries penetrated to the country between the Flint and Chattahoochee rivers. Later the Spanish made expeditions to the north to drive out English intruders, and in 1689 a fort was established at the Apalachicola Indian village, located probably near the present town of Chattahoochee at the confluence of the Flint and Chattahoochee.

At the termination of the Creek War in 1814, the Creeks were forced by General Andrew Jackson to cede to Georgia all their lands south of a line running through the present towns of Fort Gaines, Albany, and Jesup, although the Lower (or southern) Creeks had not taken part in the hostilities. In 1826 and 1827 the Georgia Creeks were stripped of the remainder of their land in western Georgia, and were shipped west of the Mississippi River.

With the removal of the Indians immigration of settlers from other parts of Georgia and the southern states soon began, and the real exploitation and destruction of the natural vegetation commenced. By burning and destructive logging practices all the virgin stands of *Pinus palustris* and *Taxodium distichum* were destroyed. Only the less desirable hardwoods were left unscathed in a few places, and these may have but a brief future. During the botanical survey in 1947 the writer observed the removal of much timber without application of basic forestry practices. Clearing of woodlands for cultivation still continues, and much acreage is under cultivation with stumps or the girdled trees still standing in the fields. As the forests disappeared, the turpentine and lumbering industries gave way in relative importance to the agricultural and grazing industries although in some counties turpentine and logging are still an important source of income.

BOTANICAL COLLECTING IN SOUTHWESTERN GEORGIA

Although many botanists have traveled through southwestern Georgia, some collecting a few specimens of vascular plants en route, apparently only

Dr. R. M. Harper (in 1896-1904) and Dr. W. H. Duncan (in 1939-1941, 1946) have done extended collecting in the region. As indicated by specimens seen in herbaria or cited in monographs, the following persons have made at least a few collections of vascular plants in southwestern Georgia: F. Rugel, Decatur County, no date; E. A. Smith, Decatur County, 1880; A. W. Latimer, Lumpkin, 1885; A. W. Chapman, Bainbridge, 1892; F. S. Earle, Lee County, 1895; J. K. Small, Albany, 1895; R. M. Harper, Sumter County and general, 1896-1904; S. M. Tracy, Dougherty, Mitchell, and Sumter counties, 1897; A. W. Curtiss, Calhoun, Decatur, and Lee counties, 1899-1901; C. L. Pollard and W. R. Maxon, Albany, 1900; W. W. Eggleston, Camilla, 1909; J. H. Miller, Albany, 1924; J. W. Gillespie, Albany, 1928; H. K. Svenson, Worth County, 1929; E. T. Wherry, general, 1932; F. W. Pennell, Sumter County, no date; L. H. MacDaniels, Albany, 1936; A. D. McKellar, Dougherty, Lee and Mitchell counties, 1936-1937; J. H. Pyron and R. McVaugh, general, 1937-1938; W. H. Duncan, general, 1939-1941, 1946; D. E. Eyles, Baker and Lee counties, 1940; S. J. Smith et al., Calhoun, Clay, Randolph, and Worth counties, 1948. During the period of the writer's survey (1946-1949) many of his collections were made in the company of W. C. Muenscher, who spent months with him in the field, W. H. Duncan, S. J. Smith, R. M. Harper, C. H. Ford, M. H. Goodwin, and R. A. Norris.

ANNOTATED CATALOGUE OF VASCULAR PLANTS

Explanation of annotated catalogue.—Arrangement of families in the catalogue largely follows the system of Engler and Diels. Genera within the families and species within the genera are arranged alphabetically. In nomenclature the International Rules have been followed. Available taxonomic monographs and revisions, recent floras, and other recent taxonomic literature have been consulted to bring the nomenclature and taxonomic treatments up to date. The writer has in general used his own judgment in the treatment of species and in the application of names. Intraspecific names are avoided except for well-defined subspecies and the equivalent geographical varieties still used by some botanists. Forms and varieties without geographical or ecological significance have been omitted.

When the scientific name used in the catalogue differs from that used in Small's *Manual of the Southeastern Flora* (1933), referred to in the catalogue simply as the *Manual*, the *manual* name is given as a synonym. Since the writer's concept of genera and species differs from Small's, many of the genera and species listed in the *Manual* are included in this catalogue only as synonyms. When available, popular names are given after the scientific names.

The statement of habitat made for each species is drawn almost entirely from the writer's field experience in the area. Possibly in certain other regions the statements might not apply for the same species. Introduced species are indicated by an asterisk. Certain cultivated plants that are occasionally spontaneous in our area, but probably not established, are given in parentheses.

The frequency terms used in the catalogue are arbitrary and are based on the following scale: rare—3 or fewer stations recorded, infrequent—4-9 stations recorded, frequent—10-19 stations recorded, common—20 or more stations recorded. In addition the terms *abundant* and *dominant* are sometimes used to denote density in place. For brevity no collections are cited; however, defi-

rell, 7. Lee, 8. Worth, 9. Dougherty, 10. Calhoun, 11. Clay, 12. Early, 13. Miller, 14. Baker, 15. Mitchell, 16. Grady, 17. Decatur, 18. Seminole.

Of the 1750 species of vascular plants listed as growing without cultivation in southwestern Georgia (excluding the species that are spontaneous but doubtfully naturalized), 1700 were collected by the writer during the survey from 1946-1949. Specimens from the area of 23 others have been examined by the writer. The 27 species listed in the catalogue of which no specimens have been seen by the writer are based on reliable reports, and for each the source of the report is cited.

The writer has checked all of his determinations against specimens (especially exsiccatae or material annotated by authorities) deposited in the Wiegand Herbarium at Cornell University. When he doubted the identity of critical material, he submitted the specimens to authorities for study. The specialists who have generously checked his determinations in special groups are C. R. Ball, *Salix*; S. F. Blake, *Helianthus* and *Hypochaeris*; R. T. Clausen, *Najas*; E. L. Core, *Scleria*; A. Cronquist, *Bumelia* and critical specimens of Compositae, especially *Aster* and *Solidago*; N. C. Fassett, *Callitriche*; L. O. Gaiser, *Liatris*; H. A. Gleason, *Vernonia*; D. G. Huttleston, *Arisaema*; D. Isely, *Desmodium*; G. Miller, *Fraxinus*; W. C. Muenscher, *Potamogeton*, *Najas*, Lemnaceae, *Utricularia*, and several smaller aquatic groups; S. J. Smith, *Trillium* and *Rubus*; C. Taylor, *Festuca*; E. E. Terrell, *Houstonia*; E. T. Wherry, *Phlox*. The writer gratefully acknowledges their expert assistance, but accepts full responsibility for any errors in identification anywhere in the catalogue.

Approximately 18,000 sheets collected by the writer during the survey of the flora of southwestern Georgia have been distributed to various herbaria. The first set has been deposited in the Wiegand Herbarium of Cornell University, and other sets have been deposited in the following herbaria, listed in order of number of sheets received: Emory University Field Station, Newton, Georgia; University of Georgia, Athens; State University of Iowa, Iowa City; Gray Herbarium, Cambridge, Massachusetts; Institut Botanique, Université de Montreal, Montreal, Canada; National Museum, Smithsonian Institution, Washington, D. C.; New York Botanical Garden, New York; Chicago Museum of Natural History, Chicago, Illinois; Missouri Botanical Garden, St. Louis; University of California, Berkeley; Washington State College, Pullman; University of Michigan, Ann Arbor. For permission to examine specimens of Georgia plants deposited in herbaria, the writer is indebted to Dr. R. T. Clausen, Curator of the Wiegand Herbarium at Cornell University, Dr. E. P. Killip, formerly Head Curator of the National Herbarium, and Dr. W. H. Duncan, Curator of the Herbarium of the University of Georgia. Dr. Duncan has also generously supplied lists of his collections in southwestern Georgia, and has spent much time searching through the herbarium of the University of Georgia for specimens of many critical species. Dr. R. M. Harper has given explicit directions for finding interesting stations and plants discovered by him many years ago.

LYCOPODIACEAE—Club-moss Family

Lycopodium alopecuroides L.—Moist pinelands, frequent.

L. carolinianum L.—Moist pinelands, 1, 10, 13, 15, 17, infrequent.

L. cernuum L.—Seepage moistened clay banks of railway cuts near Coleman, 5, rare.

L. inundatum L. var. *bigelovii* Tuckerm. (*L. adpressum* (Chapm.) Lloyd & Underw.).—Moist sandy ground, 6, rare.

L. inundatum L. var. *pinnatum* Chapm. (*L. prostratum* Harper).—Moist pinelands, 1, 10, 13, 17, infrequent.

SELAGINELLACEAE—Spike-moss Family

Selaginella apoda (L.) Spring. (incl. *S. ludoviciana* A. Br.).—Rich woods, frequent.

S. arenicola Underw.—Dry sand, 9, 17, rare.

ISOETACEAE—Quillwort Family

Isoetes engelmanni A. Br. var. *caroliniana* A. A. Eat.—Sluggish pine-barren stream, 1, rare.

I. flaccida Shuttlew.—Sluggish streams and shallow, grassy ponds on the Dougherty Plain, 1, 9, 13, 14, infrequent.

EQUISETACEAE—Horsetail Family

Equisetum hyemale L. var. *affine* (Engelm.) A. A. Eat. (*E. praealtum* Raf.).—Banks of the Chattahoochee River, 11, 12, 18, infrequent.

OPHIOGLOSSACEAE—Adder's-tongue Family

Botrychium alabamense Maxon.—Vicinity of Albany, 9, (Clausen 1938), rare.

B. dissectum Spreng. subsp. *dissectum* (incl. var. *tenuifolium* (Underw.) Farw.).—Frequent in moist woods; occasional in sandy hammocks.

B. virginianum (L.) Sw. subsp. *virginianum*.—Rich woods, frequent.

OSMUNDACEAE—Cinnamon Fern Family

Osmunda cinnamomea L. Cinnamon fern.—Moist pinelands, seepage slopes, moist woods, swamps, and ravine bottoms, common.

O. regalis L. var. *spectabilis* (Willd.) A. Gray.—Swamps, wet woods, seepage slopes, and ravine bottoms, common.

SCHIZAEACEAE—Curly-grass Family

**Lygodium japonicum* (Thunb.) Sw.—Frequent in bottom-lands along the lower part of the Chattahoochee River; rare along the Flint River.

POLYPODIACEAE—Fern Family

Adiantum capillus-veneris L. Venus'-hair fern.—Frequent on steep, often perpendicular, banks, and rocky walls of bluffs, gorges, ravines, and limesinks; confined largely to the Red Hills and the Escarpment.

A. pedatum L. Maidenhair fern.—Rich woods along Cemochechobee Creek and its tributary Hog Creek, 11, rare.

Asplenium platyneuron (L.) Oakes. Ebony spleenwort.—Dry or rocky woods, often on boulders, and usually along streams, common.

A. resiliens Kunze. Little ebony spleenwort.—Limestone outcrops, 5, 7, 17, rare.

Athyrium filix-femina (L.) Roth var. *asplenoides* (Michx.) Farwell (*A. asplenoides* (Michx.) Desv.) Lady fern.—Rich woods, common.

Dryopteris ludoviciana (Kunze) Small (*D. floridana* (Hook.) Kuntze). Shield Fern.—Moist or swampy woods, 1, 10, 11, 12, 14, infrequent.

Onoclea sensibilis L. Sensitive fern.—Swampy woods, especially along the Chattahoochee River and its tributaries, frequent.

Pellaea atropurpurea (L.) Link. Cliff-brake.—Limestone outcrops near Greer's Cave, 5, rare.

Polypodium polypodioides (L.) Watt. var. *michauxianum* Weatherby. Resurrection fern.—Common on tree trunks, especially the trunks and spreading branches of the live oak; occasional on rocks.

Polystichum acrostichoides (Michx.) Schott. Christmas fern.—Rich, moist or rocky woods, usually along streams, common.

Pteridium aquilinum (L.) Kuhn. subsp. *pseudocaudatum* (Clute) Hult. (*Pteris latiuscula* Desv.). Bracken.—Dry woods and open places, abundant.

- Thelypteris dentata* (Forsk.) E. St. John.—Moist, rich woods, 6, 12, 13, infrequent.
T. hexagonoptera (Michx.) Slosson (*Phegopteris hexagonoptera* (Michx.) Fée). Beech fern.—Rich, moist woods on ravine slopes in the Red Hills, 5, 11, 12, infrequent.
T. normalis (C. Chr.) Moxley.—Wet banks and rich, moist or rocky woods, frequent.
T. palustris (Salisb.) Schott (*T. thelypteris* (L.) Nieuwl.). Marsh fern.—Swampy woods and moist pinelands, 1, 5, 6, 7, 12, infrequent.
Woodisia obtusa (Spreng.) Torr. Cliff fern.—Banks and bluffs of the Chattahoochee River, 12, 17, 18, infrequent.
Woodwardia areolata (L.) Moore (*Lorinseria areolata* (L.) Presl.). Chain fern.—Swamps, bogs, and wet woods, especially along streams, common.
W. virginica (L.) J. E. Smith (*Anchistea virginica* (L.) Presl.). Chain fern.—Moist pinelands, cypress swamps, and swampy woods, common.

PINACEAE—Pine Family

- Pinus echinata* Mill. Short-leaf pine.—Frequent on the sandy Dougherty Plain, and common in the drier soils of the Red Hills, there replacing *P. palustris*.
P. elliotii Engelm. (*P. palustris* of the *Manual*). Slash pine.—Wet pinelands and shallow cypress ponds, common.
P. glabra Walt. Spruce pine.—Hammocks, bottoms, and wooded ravine slopes, often with *Fagus grandifolia caroliniana* and *Magnolia grandiflora*, common.
P. palustris Mill. (*P. australis* Michx. f.). Long-leaf pine, yellow pine.—Dominant tree throughout the Dougherty Plain in dry, sandy pinelands; less common elsewhere.
P. rigida Mill. ssp. *serotina* (Michx. f.) Clausen (*P. serotina* Michx. f.). Pond pine.—Bogs and sandy swamps, 1, 3, 5, 12, 17, infrequent.
P. taeda L. Loblolly pine, old-field pine.—Near streams and usually in less dry situations than *P. palustris*, common.

TAXODIACEAE—Bald-cypress Family

- Taxodium ascendens* Brongn. Pond-cypress.—Common in wet pinelands and dominant in shallow cypress ponds and around deep permanent ponds on the Dougherty Plain.
T. distichum (L.) L. C. Rich. Bald-cypress.—Common along streams and abundant in alluvial swamps.

CUPRESSACEAE—Cypress Family

- Juniperus virginiana* L. (*Sabina virginiana* (L.) Antoine). Red-cedar.—Sandy hammocks, and along streams, common.

TAXACEAE—Yew Family

- Torreya taxifolia* Arn. (*Tumion taxifolium* (Arn.) Greene). Torreya, Stinking-cedar.—Found in only two or three ravines north of the Florida state line in the bluff east of the Flint River, near its junction with the Chattahoochee River, 17.

TYPHACEAE—Cat-tail Family

- Typha latifolia* L. Cat-tail.—Marshes and ditches, frequent.

SPARGANIACEAE—Bur-reed Family

- Sparganium americanum* Nutt. (incl. *S. androcladum* (Engelm.) Morong). Bur-reed.—Shallow water of swamps, 1, 10, 14, rare.

ZOSTERACEAE—Pondweed Family

- Potamogeton capillaceus* Poir. (*P. diversifolius* of the *Manual* in part.).—Shallow water of ponds and slow streams, frequent.
P. diversifolius Raf. (*P. diversifolius* of the *Manual* in part.).—Ponds, ditches, borrow-pits, and slow streams, frequent.
P. illinoensis Morong (*P. angustifolius* and *P. lucens* of the *Manual*).—Shallow water of ponds and sluggish streams, 7, 12, 14, 17, infrequent.
P. nodosus Poir. (*P. fluitans* Roth).—Clear, swift stream flowing from Radium Springs near the Flint River, 4 miles south of Albany, 9, rare.
P. pulcher Tuckerm.—Cypress ponds and lakes, 1, 8, 10, 14, infrequent.

P. pusillus L. (*P. panormitanus* Biv.).—Shallow water of Mill Creek just below the dam at Sheffield Mill, 12, rare.

NAJADACEAE—Naiad Family

Najas conferta A. Br.—Cane Water Pond, Open Pond, and Douglas Lake, 17, rare.

N. guadalupensis (Spreng.) Magnus (incl. var. *curassavica* (A. Br.) Urban).—Clear springs, streams, and ponds, 7, 9, 12, rare.

ALISMATACEAE—Water-plantain Family

Echinodorus cordifolius (L.) Griseb. (*E. radicans* (Nutt.) Engelm.).—Wet margins of ponds, 12, 17, rare.

E. rostratus (Nutt.) Engelm. (*E. cordifolius* of the *Manual*) Burhead.—Shallow water and wet mud along Big Cypress Creek, 14, rare.

E. tenellus (Mart.) Buchenau (*Helanthis parvulum* (Engelm.) Britt.).—Shallow water and wet margins of ponds, 9, 15, 17, infrequent.

Sagittaria chapmani (J. G. Smith) C. Mohr.—Alluvial swamps, sluggish streams, and ponds, frequent.

S. graminea Michx.—Shallow water of ponds, common.

S. isoetiformis J. G. Smith.—Shallow water and wet margins of ponds, 7, 17, infrequent.

S. latifolia Willd. (incl. *S. pubescens* Muhl.). Wapato.—Marshes, swampy woods, and wet ravine bottoms, mostly in the Red Hills, common.

S. subulata (L.) Buchenau subsp. *lorata* (Chapm.) Clausen (*S. stagnorum* Small, *S. lorata* (Chapm.) Small).—Shallow water of ponds, frequent.

HYDROCHARITACEAE—Frog's Bit Family

Limnium spongia (Bosc.) Steud. Frog's bit.—Shallow water at the margin of cypress swamps and ponds, 12, 14, 17, rare.

GRAMINEAE—Grass Family

Agrostis eliottiana Schultes.—Roadsides, 9, 12, rare.

A. hymenalis (Walt.) B. S. P. Ticklegrass.—Roadsides and moist open ground, frequent.

A. perennans (Walt.) Tuckerm. Autumn bent.—Dry, open ground along streams, 11, 12, 14, 15, 18, infrequent.

Alopecurus carolinianus Walt.—Roadsides and waste places, 9, 11, 18, rare.

Andropogon eliottii Chapm.—Dry, open woods and old fields, frequent.

A. gerardi Vitman. (*A. provincialis* of the *Manual*, *A. furcatus* Muhl.). Blue stem.—Pinelands and dry woods generally, frequent.

A. hirtiflorus (Nees) Kunth.—Dry, sandy oak woods on the Dougherty Plain, 7, 9, 14, 17, infrequent.

A. scoparius Michx. Little blue stem.—Dry slopes and dry, open woods, 1, 11, 12, infrequent.

A. tener (Nees) Kunth.—Dry pinelands and old fields on the Dougherty Plain, 1, 6, 9, 17, infrequent.

A. ternarius Michx.—Dry, sandy soil in open woods and old fields, frequent.

A. virginicus L. (incl. *A. glomeratus* (Walt.) B.S.P., *A. longiberbis* Hack., *A. capillipes* Nash) Broom-sedge.—Pinelands, dry or moist ground, old fields, and open woods, very common.

Anthracanthes rufa (Ell.) Schultes.—Moist pinelands, 14, rare.

A. villosa (Michx.) Beauv.—Dry pine or oak woods, frequent.

Aristida affinis (Schultes) Kunth (*A. palustris* (Chapm.) Vasey).—Moist pinelands and shallow cypress ponds, 1, 7, 12, 14, infrequent.

A. dichotoma Michx.—Dry, sterile soil, 14, rare.

A. lanosa Muhl.—Dry soil, 1, 3, 10, 12, 14, 17, infrequent.

A. longesepica Poir.—Dry, sandy woods, 10, 17, rare.

A. oligantha Michx.—Dry, open ground, 1, 9, rare.

A. purpurascens Poir.—Dry, sandy woods and fields, 1, 11, 12, infrequent.

A. spiciformis Ell.—Moist pinelands, 12, 13, rare.

- A. stricta* Michx.—Dry, sandy pinelands on the Dougherty Plain, common.
- A. tuberculosa* Nutt.—Dry sandy oak-barrens along Ichawynochaway Creek, 14, rare.
- A. virgata* Trin.—Sandy pinelands, 1, 5, 7, 9, 10, 14, infrequent.
- Arundinaria gigantea* (Walt.) Muhl. Giant cane.—Infrequent along the larger streams on alluvium; apparently much more abundant formerly, 1, 3, 12, 14, 18.
- A. tecta* (Walt.) Muhl. Small cane.—Common in bogs, sandy swamps, wet ravine bottoms and on seepage slopes, chiefly in the Red Hills and along the Escarpment; rare on the Dougherty Plain.
- **Arundo donax* L. Giant reed.—Roadsides and dry fields, infrequent; perhaps not spontaneous.
- **Avena sativa* L.—Oat.—Roadsides and waste places, frequent.
- Axonopus compressus* (Swartz) Beauv. Carpet grass.—Moist, open ground, frequent.
- A. furcatus* (Flügge) Hitchc.—Moist places near streams and ponds, 13, 14, 17, infrequent.
- Brachyelytrum erectum* (Schreb.) Beauv.—Rich, loamy, wooded ravine slopes, 5, rare.
- **Bromus catharticus* Vahl (*B. unioloides* H.B.K.). Brome grass.—Roadsides, railroad yards, and waste places, mostly in towns, frequent.
- B. purgans* L.—Rich, calcareous, wooded slope near Indian Den along Fowltown Creek, 7, rare.
- **B. secalinus* L. Chess, cheat.—Along railroad in and near Donaldsonville, 18, rare.
- Cenchrus echinatus* L. Sandbur.—Common weed of waste places, roadsides, and fields.
- C. incertus* M. A. Curtis.—Dry, sandy, open places, mainly on the Dougherty Plain, 1, 9, 11, 14, infrequent.
- C. pauciflorus* Benth.—Dry, sandy, open woods and waste places, 9, 14, 17, infrequent.
- Chloris floridana* (Chapm.) Wood. Finger grass.—Sandy banks of the Flint River and its tributaries, 14, 17, infrequent.
- C. glauca* (Chapm.) Wood.—Moist, sandy places, 8, 9, 14, rare.
- C. petraea* Swartz.—Sandy banks of the Flint River and its tributaries, 14, 17, infrequent.
- Ctenium aromaticum* (Walt.) Wood (*Campulosus aromaticus* (Walt.) Trin.) Toothache grass.—Moist pinelands, frequent.
- **Cynodon dactylon* (L.) Pers. (*Capriola dactylon* (L.) Kuntze) Bermuda grass.—Common weed of roadsides and waste places.
- **Dactyloctenium aegyptium* (L.) Beauv. Egyptian grass.—Frequent weed of waste places, roadsides, and fields.
- Danthonia sericea* Nutt. Oat grass.—Dry woods, 3, 5, 7, 9, 10, 11, 12, infrequent.
- **Digitaria sanguinalis* (L.) Scop. Crab grass.—Common weed of waste grounds, roadsides, and fields.
- **D. violascens* Link.—Waste ground, Colquitt, 13, rare.
- **Echinochloa colonum* (L.) Link. Jungle-rice.—Moist places, especially near streams, 13, 15, 17, infrequent.
- **E. crusgalli* (L.) Beauv. (incl. *E. pungens* (Poir.) Rydb.). Barnyard grass.—Waste places and moist ground, 9, 12, infrequent.
- E. walteri* (Pursh) Heller.—Moist ground, 1, 9, 11, rare.
- **Eleusine indica* (L.) Gaertn. Goose grass.—Common weed of waste places and roadsides.
- Elymus virginicus* L. Wild-rye.—Along streams, frequent.
- Elyonurus tripsacoides* Humb. and Bonpl.—Pinelands, 8, 10, infrequent.
- **Eragrostis amabilis* (L.) Wight and Arn. Love grass.—Roadsides, waste places, and cultivated fields, infrequent.
- **E. ciliaris* (L.) R. Br.—Waste places, 14, 17, rare.
- E. elliottii* S. Wats.—Sandy open places, 14, 18, rare.
- E. glomerata* (Walt.) L. H. Dewey.—Frequent on banks of the Chattahoochee River; not seen elsewhere.
- E. hirsuta* (Michx.) Nees.—Dry, sandy fields and open woods, frequent.
- E. hypnoides* (Lam.) B.S.P.—Moist, sandy ground, 9, 18, rare.
- E. pectinacea* (Michx.) Nees.—Waste places, roadsides, and river banks, 9, 14, 18, infrequent.
- **E. pilosa* (L.) Beauv.—Waste ground, Colquitt, 13, rare.
- E. refracta* (Muhl.) Scribn.—Sandy, open woods and banks of streams and ponds, mostly on the Dougherty Plain, frequent.

- E. simplex* Scribn.—Waste places and roadsides, 14, 17, rare.
E. spectabilis (Pursh) Steud. Purple love grass.—Dry, sandy fields and open woods, 7, 9, 17, infrequent.
 **E. unioloides* (Retz.) Nees.—Moist, sandy roadsides near Keel Creek, 5 miles south of Leary, 10, rare.
Erianthus alopecuroides (L.) Ell. (*E. divaricatus* A. Hitchc.). Silver plume grass.—Near Fort Gaines along the dry border of woods, 11, rare.
E. coarctatus Fern. (*E. brevibarbis* of the *Manual* in part). Brown plume grass.—Moist places, especially pond margins, 8, 10, 12, 14, infrequent.
E. contortus Baldw. Bent-awn plume grass.—Moist, open places and dry woods, 9, 10, 11, 12, 17, infrequent.
E. giganteus (Walt.) Muhl. (*E. saccharoides* Michx.). Giant plume grass.—Swamps and marshy places, frequent.
E. strictus Baldw. Narrow plume grass.—Along streams, 5, 12, 14, infrequent.
Festuca obtusa Bieler. Nodding Fescue.—Rich, moist woods along Fowltown Creek, 7, rare.
F. octoflora Walt. Sixweeks Fescue.—Dry, sandy, open places, frequent.
F. paradoxa Desv. (*F. shortii* Kunth).—Waste places near the railroad terminal at Fort Gaines, 11, rare.
F. sciurea Nutt.—Sandy, open ground, 2, 9, 14, 17, infrequent.
Glyceria striata (Lam.) A. Hitchc. (*Panicularia striata* (Lam.) A. Hitchc.) Manna grass.—Wet places, especially in swampy woods along streams, frequent.
Gymnopogon ambiguus (Michx.) B.S.P.—Dry pinelands, frequent.
G. brevifolius Trin.—At the edge of the Tifton Upland in rolling pineland, 8, rare.
**Hackelochloa granularis* (L.) Kuntze (*Rytidix granularis* (L.) Skeels).—Cultivated and waste ground near Bainbridge, 17, rare.
Heteropogon melanocarpus (Ell.) Benth.—Fields and roadsides, 7, 9, 12, 14, 17, 18, infrequent.
Hordeum pusillum Nutt. Little wild barley.—Roadsides and waste places, frequent.
Hydrochloa carolinensis Beauv. Floating-leaf grass.—Shallow water of ponds and ditches on the Dougherty Plain, frequent.
Leersia hexandra Swartz (*Homalocenchrus hexandrus* (Swartz) Kuntze).—Shallow water of intermittent pineland ponds and permanent ponds, often in association with *Panicum hemitomon*, common.
L. lenticularis Michx. (*Homalocenchrus lenticularis* (Michx.) Kuntze) Catchfly grass.—Swamps and wet woods, 7, 12, 14, 15, infrequent.
L. oryzoides (L.) Swartz (*Homalocenchrus oryzoides* (L.) Sw.). Rice cutgrass.—Wet woods in the Red Hills, 1, 11, 12, infrequent.
L. virginica Willd. (*Homalocenchrus virginicus* (Willd.) Britt.) White grass.—Frequent in moist woods along the Chattahoochee River; rare elsewhere.
Leptochloa filiformis (Lam.) Beauv. Red sprangletop.—Collected in 1885 near Lumpkin, 3.
Leptoloma cognatum (Schultes) Chase. Fall witch grass.—Dry, sandy field, 9, 10, 14, infrequent.
**Lolium multiflorum* Lam. Italian rye-grass.—Waste places, 9, 17, 18, infrequent.
Manisuris cylindrica (Michx.) Kuntze (*M. campestris* (Nutt.) Hitchc.).—Dry, sandy pinelands on the Dougherty Plain, 1, 7, 9, 10, 12, 18, infrequent.
M. rugosa (Nutt.) Kuntze.—Moist pinelands, 1, 8, 9, 10, infrequent.
Melica mutica Walt. Melic grass.—Rich, dry woods, largely in the Red Hills, 5, 7, 10, 11, 12, 17, infrequent.
**Microstegium vimineum* (Trin.) A. Camas (*Eulalia viminea* (Trin.) Kuntze).—Bottom woods and banks of the Chattahoochee River, 12, 18, infrequent.
Muhlenbergia capillaris (Lam.) Trin. Hair grass.—Open, sandy places, 1, 14, rare.
M. expansa (DC.) Trin.—Dry pinelands and oak woods of the Dougherty Plain, frequent.
M. schreberi J. F. Gmel. Nimblewill.—Moist woods, 7, 18, rare.
M. torreyana (Schultes) A. Hitchc. (*Sporobolus torreyanus* (Schultes) Nash).—Moist pinelands, 1, 7 (Harper 1901, 1903).
Oplismenus setarius (Lam.) Roem. & Schult.—Rich woods and banks and bluffs of the larger streams, common.
Panicum aciculare Desv.—Sandy pinelands and oak woods, frequent.

- P. agrostoides* Spreng. (incl. *P. condensum* Nash).—Wet places, especially along streams and around ponds, common.
- P. albomarginatum* Nash (incl. *P. trifolium* Nash).—Moist pinelands, seepage slopes, and dry woods, 12, 13, 14, 17, infrequent.
- P. anceps* Michx. (incl. *P. rhizomatum* Hitchc. & Chase).—Moist pinelands, sloughs and wet bottoms along streams, and moist places generally, common.
- P. angustifolium* Ell.—Sandy pine woods, 1, 9, 17, rare.
- P. arenicoloides* Ashe.—Dry, sandy pine and oak woods, 14, 17, rare.
- P. auburne* Ashe.—Vicinity of Bainbridge, 17, rare.
- P. boscii* Poir. (incl. var. *molle* (Vasey) Hitchc. & Chase.).—Frequent in rich woods in the Red Hills and along the escarpment; rare elsewhere.
- P. caeruleus* Hack.—Wet, open areas, 7, 14, rare.
- P. chamaelonche* Trin.—Moist, sandy pinelands, 12, 13, 14, 17, infrequent.
- P. chrysipidifolium* Nash.—Sandy pinelands near Fox Pond, 7, rare.
- P. ciliatum* Ell.—Moist pinelands, 10, 12, 17, infrequent.
- P. commutatum* Nash (incl. *P. joorii* Vasey, *P. ashei* Pearson, *P. mutabile* Scribn. & Smith).—Rich, rocky, moist, or swampy woods, dry, sandy hammocks and pine lands, and along streams, very common.
- P. curtifolium* Nash.—Bogs and seepage slopes, 11, 12, 17, infrequent.
- P. dichotomiflorum* Michx.—Frequent in wet places along streams, and occasionally a weed in waste places.
- P. dichotomum* L. (incl. *P. barbulatum* Michx.).—Dry woods, 9, 11, 14, infrequent.
- P. ensifolium* Baldw.—Wet places, 5, 13, 17, infrequent.
- P. erectifolium* Nash.—Moist pinelands and shallow ponds, 1, 9, 10, 18, infrequent.
- P. fusiforme* A. Hitchc.—Dry, wooded slope of a bluff along the Flint River, 17, rare.
- P. gymnocarpon* Ell.—Stream banks, 1, 6, rare.
- P. hemitonum* Schultes. Maidencane.—Shallow water of intermittent and permanent ponds, common.
- P. hians* Ell.—Wet places, especially shallow pineland ponds and borrow-pits, common.
- P. implicatum* Scribn. (incl. *P. huachucae* Ashe).—Sandy, oak-pine woods and clearings, 1, 14, rare.
- P. lancearium* Trin. (incl. *P. patulum* (Scribn. & Merr.) Hitchc., *P. webberianum* Nash).—Moist pinelands, 10, 13, rare.
- P. lanuginosum* Ell.—Open, sandy woods and roadsides, 6, 12, rare.
- P. laxiflorum* Lam. (incl. *P. xalapense* H.B.K.).—Rich, moist, rocky, or dry, open woods, frequent.
- P. leucothrix* Nash.—Moist pinelands and shallow margins of cypress ponds, 10, 13, 14, 15, infrequent.
- P. lindheimeri* Nash.—Dry, sandy woods and open places, 1, 14, rare.
- P. longifolium* Torr. (incl. *P. combsii* Scribn. & Ball).—Moist pinelands, 1, 5, 9, 10, 13, 14, infrequent.
- P. longiligulatum* Nash.—Moist pinelands and shallow cypress ponds, 1, 10, 12, rare.
- P. lucidum* Ashe.—Boggy swamp near Hilton, 12, rare.
- P. microcarpon* Muhl.—Moist woods, 1, 9, 11, 12, 17, infrequent.
- P. nitidum* Lam.—Seepage slope along Sanborn Creek, 17, rare.
- P. oligosanthos* Schultes.—Dry, sandy woods, 1, 10, 14, infrequent.
- P. ovale* Ell.—Dry, sandy woods near Hilton, 12, rare.
- P. polycaulon* Nash.—Boggy places near Faceville, 17, rare.
- P. ravenelii* Scribn. & Merr.—Dry, sandy pinelands, 1, 7, 14, 17, infrequent.
- P. roanokense* Ashe.—Moist pineland, 7, 9, rare.
- P. scabriusculum* Ell.—Moist pinelands and boggy places, 1, 6, 12, infrequent.
- P. scoparium* Lam.—Moist, sandy soil, frequent.
- P. sphaerocarpon* Ell. (incl. var. *inflatum* (Scribn. & Small) Hitchc. & Chase).—Dry, sandy woods, 1, 5, 9, 11, 14, infrequent.
- P. spretum* Schultes.—Shallow water of wet pinelands and cypress ponds, 9, 13, 14, infrequent.
- P. tenerum* Beyr.—Moist pinelands and open, grassy places, 1, 12, 13, rare.
- P. tenue* Muhl.—Pine lands and cypress swamps, 13, 14, rare.
- **P. texanum* Buckl.—Dump near Blakely, 12, rare.
- P. verrucosum* Muhl.—Moist pinelands and sphagnum seepage slopes, 1, 11, 12, 13, 14, infrequent.

- P. villosissimum* Nash (incl. *P. pseudopubescens* Nash).—Dry, sandy pinelands and oak woods, 7, 10, 12, 14, 15, 17, infrequent.
- P. virgatum* L. (incl. var. *cubense* Griseb.). Switch grass.—Dry, open woods, common.
- P. wrightianum* Scribn.—Moist pinelands and margins of ponds, 12, 13, 14, 15, 17, infrequent.
- Paspalum bifidum* (Bertol.) Nash.—Sandy pinelands, 1, 8, rare.
- P. boscianum* Flüggé.—Cultivated ground, ditches, and wet, open places on the Dougherty Plain, infrequent.
- P. ciliatifolium* Michx. (incl. *P. pubescens* Muhl.).—Open, sandy woods, frequent.
- P. debile* Michx.—Sandy bank of the Flint River, 14, rare.
- P. difforme* LeConte.—Moist, sandy pinelands, 12, 14, rare.
- **P. dilatatum* Poir. Dallis-grass.—Roadsides, waste places, and stream banks, frequent.
- P. distichum* L.—Ditches, 1, 9, 13, rare.
- P. floridanum* Michx. (incl. var. *glabratum* Engelm.).—Moist pinelands and open places, frequent.
- P. fluitans* (Ell.) Kunth (*P. repens* of the *Manual*, not Berg.).—Alluvial sandbank of the Chattahoochee River, 12, rare.
- P. giganteum* Baldw.—Along Spring Creek, 17, rare.
- P. laeve* Michx. (incl. *P. longipilum* Nash).—Moist pinelands and margins of ponds, frequent.
- P. lentiferum* Lam.—Moist pinelands and borders of cypress ponds, 10, 12, 15, infrequent.
- P. plicatulum* Michx.—Waste ground, ditches, old fields, and pond margins, mainly on the Dougherty Plain, frequent.
- P. praecox* Walt.—Moist pinelands and borders of cypress ponds, 9, 10, 12, 13, infrequent.
- P. setaceum* Michx. (incl. *P. longepedunculatum* LeConte).—Dry, open, sandy places, 13, 14, 17, infrequent.
- **P. urvillei* Steud. Vasey grass.—Roadsides and waste places, common.
- Phalaris caroliniana* Walt.—Fields, roadsides, and waste places, 3, 9, 10, 12, infrequent.
- (**Phleum pratense* L. Timothy.—Railroad yards in Leary, 10; rare; apparently not naturalized.)
- **Poa annua* L. Annual spear grass.—Waste places, roadsides, and lawns, frequent.
- P. autumnalis* Muhl.—Moist, rich woods in the Red Hills, 2, 11, 12, infrequent.
- P. chapmaniana* Scribn.—Open ground, 11, 14, rare.
- P. cuspidata* Nutt.—Rich, loamy, wooded ravine slopes in the Red Hills, 11, rare.
- Sacciolepis striata* (L.) Nash.—Shallow water of ponds, 6, 7, 14, 17, infrequent.
- (**Secale cereale* L. Rye.—Spontaneous along a roadside near Leary, 10.)
- Setaria corrugata* (Ell.) Schult. (*Chaetochloa corrugata* (Ell.) Scribn.). Foxtail.—Sandy woods and banks of streams, 12, 14, 17, 18, infrequent.
- S. geniculata* (Lam.) Beauv. (*C. geniculata* (Lam.) Millsp. & Chase).—Waste places, roadsides, pond margins, and pinelands, mainly on the Dougherty Plain, frequent.
- **S. lutescens* (Weigel) F. T. Hubbard. (*C. lutescens* (Weigel) Stuntz). Yellow foxtail.—Railroad yards, 10, 11, rare.
- **S. viridis* (L.) Beauv. (*C. viridis* (L.) Scribn.). Green foxtail.—Railroad yards, 1, 10, 18, rare.
- Sorghastrum elliptii* (Mohr) Nash.—Dry, open woods, frequent.
- S. nutans* (L.) Nash. Indian grass.—Dry, open places, frequent.
- S. secundum* (Ell.) Nash.—Dry, sandy pinelands on the Dougherty Plain, frequent.
- **Sorghum halepense* (L.) Pers. (*Holcus halepensis* L.).—Johnson grass.—Roadsides, waste places, and fields, common.
- Sphenopholis filiformis* (Chapm.) Scribn. Wedge grass.—Dry, open woods, frequent.
- S. nitida* (Bieler) Scribn.—Rich, dry, or rocky woods, mostly in the Red Hills, 5, 11, 12, 17, infrequent.
- S. obtusata* (Michx.) Scribn.—Open woods, roadsides, and moist places, 7, 9, 10, infrequent.
- Sporobolus clandestinus* (Bieler) A. Hitchc. Dropseed.—Grassy roadside north of Bluffton, 11, rare.
- S. floridanus* Chapm.—Moist pinelands, 1, 8, 14, 15, infrequent.

S. junceus (Michx.) Kunth (*S. gracilis* (Trin.) Merr.).—Dry, sandy pinelands and oak barrens, frequent.

**S. poiretii* (R. & S.) A. Hitchc. (*S. berterianus* (Trin.) Hitchc. & Chase).—Smut-grass.—Very common weed of roadsides, waste places, and open ground.

Stipa avenacea L. Needlegrass.—Frequent in dry, open woods in the Red Hills; infrequent on the Dougherty Plain.

Tridens ambiguus (Ell.) Schultes (*Triodia Elliottii* Bush, *Triodia langloisii* (Nash) Bush).—Moist pinelands and moist, open grassy places on the Dougherty Plain, frequent.

T. carolinianus (Steud.) Henr. (*Triodia drummondii* Scribn. & Kearns.).—Dry, wooded slope in pinelands near Recovery, 17, rare.

T. flavus (L.) A. Hitchc. (*Triodia flava* (L.) Smyth). Tall red-top.—Old fields, dry open woods, and roadsides, common.

T. strictus (Nutt.) Nash. (*Triodia stricta* (Nutt.) Benth.).—Moist, open grassy places and bottom woods on the Dougherty Plain, 9, 14, 18, infrequent.

Triplasis americana Beauv.—Dry sand, 9, 12, 17, infrequent.

T. purpurea (Walt.) Chapm.—Dry sand, 14, 17, rare.

Tripsacum dactyloides (L.) L. Gama grass.—Roadsides and moist places, 9, 15, infrequent.

**Triticum aestivum* L. Wheat.—Spontaneous along railroad near Donaldsonville, 18.)

Uniola latifolia Michx.—Common on the banks of streams, especially the Flint and Chattahoochee rivers; infrequent on rich, wooded slopes.

U. laxa (L.) B. S. P.—Moist or sandy woods, usually along streams, 2, 8, 10, 12, 13, 15, infrequent.

U. nitida Baldw.—Open pinelands and along streams, 10, 13, 14, infrequent.

U. sessiliflora Poir. (*U. longifolia* Scribn.).—Rich, rocky, or sandy woods, common.

(**Zea mays* L. Indian-corn, maize.—Rarely spontaneous in waste places.)

Zizaniopsis miliacea (Michx.) Doell. & Aschers.—Shallow water of stream margins near Albany, 9, rare.

CYPERACEAE—Sedge Family

Bulbostylis capillaris (L.) C. B. Clarke (*Stenophyllus capillaris* (L.) Britt.).—Sandy field, 7, rare.

B. ciliatifolia (Ell.) Fern. (*S. ciliatifolius* (Ell.) C. Mohr).—Dry, sandy soil, mostly on the Dougherty Plain, 5, 9, 10, 14, 17, infrequent.

B. coarctata (Ell.) Fern. (*S. coarctatus* (Ell.) Britt.).—Dry, sandy soil, 9, 14, rare.

**B. floridana* (Britt.) Fern. (*S. barbatus* (Rottb.) Britt.). Water-grass.—Dry, sandy soil of fields, roadsides, stream banks, and open pine or oak woods, common.

Carex abscondita Mack. (incl. *C. magnifolia* Mack.).—Rich, moist woods, chiefly in the Red Hills, 2, 11, 12, 17, infrequent.

C. alata Torr. & Gray.—Shallow water and wet margins of swamps, ponds, and ditches on the Dougherty Plain, 7, 9, 10, 14, infrequent.

C. albolutea Schwein. (*C. straminea* of the Manual).—Swamp along Cooleeewahee Creek near Pretoria, 9, rare.

C. amphibola Steud. (incl. var. *rigida* (Bailey) Fern.).—Rich, moist or rocky woods, 7, 10, 12, 17, infrequent.

C. annectens Bickn.—Dry ground of roadsides and fields, 5, 15, 17, infrequent.

C. atlantica Bailey.—Boggy swamp near Hilton, 12, rare.

C. bromoides Schkuhr.—Swampy woods, 2, 7, rare.

C. cephalophora Muhl.—Open woods, 12, 17, rare.

C. cherokeensis Schwein.—Moist, calcareous woods, 1, 12, 17, rare.

C. comosa Boott.—Shallow water of swamps and cypress ponds, 7, 9, 14, rare.

C. complanata Torr. & Hook.—Sandy or loamy woods, 5, 10, 12, 14, 17, infrequent.

C. crebriflora Wiegand.—Rich woods, chiefly in the Red Hills, 5, 11, 12, 17, infrequent.

C. crus-corvi Shuttlew.—Shallow water of swamps, 9, 12, rare.

C. dasycarpa Muhl.—Dry, sandy woods of the Dougherty Plain and the escarpment, 10, 12, 14, 17, infrequent.

C. debilis Michx.—Rich, moist or wet, woods of the Red Hills, frequent.

C. decomposita Muhl.—Shallow water and floating logs of pond margins, 14, rare.

- C. digitalis* Willd.—Rich, loamy or dry, sandy woods, frequent.
- C. festucacea* Schkuhr.—Wooded ravine near junction of Flint and Chattahoochee rivers, 17, rare.
- C. flaccosperma* Dewey.—Marly soil in ravines and along the foot of the bluff near the junction of the Flint and Chattahoochee rivers, 17, rare.
- C. floridana* Schwein.—Dry, open woods, 2, 5, 14, infrequent.
- C. frankii* Kunth.—Springy ravine bottom near Fort Gaines, 11, rare.
- C. gigantea* Rudge.—Shallow water of cypress ponds and in swampy woods on the Dougherty Plain, 8, 9, 10, 12, 13, 14, 15, infrequent.
- C. glaucescens* Ell.—Common in moist pinelands, cypress ponds, and swamps on the Dougherty Plain; infrequent in the Red Hills in bogs and swampy woods.
- C. granularis* Muhl.—Moist woods, 7, 10, 12, infrequent.
- C. howei* Mack.—Swampy woods, frequent.
- C. hyalinolepis* Steud.—Shallow water of swamp along Kiokee Creek near Pretoria, 9, rare.
- C. incomperata* Bickn.—Swampy woods, bogs, and seepage slopes, 5, 10, 11, infrequent.
- C. intumescens* Rudge.—Swampy or moist woods, 2, 5, 10, 12, 15, 16, infrequent.
- C. joori* Bailey.—Swampy woods and sloughs, 5, 7, 12, 18, infrequent.
- C. laevivaginata* (Kük.) Mack.—Wet woods along the Chattahoochee River near Hilton, 12, rare.
- C. leptalea* Wahl. (incl. *C. harperi* Fern.).—Swampy or boggy woods, frequent.
- C. lonchocarpa* Willd. (*C. smaliana* Mack.).—Swampy woods along streams, 1, 2, rare.
- C. longii* Mack.—Wet places, roadsides, ditches, and fields, on the Dougherty Plain, frequent.
- C. louisianica* Bailey.—Swampy woods, 7, 10, 12, rare.
- C. lupulina* Muhl.—Wet woods and open, marshy places, 7, 8, 9, 11, 12, 14, infrequent.
- C. lurida* Wahl.—Swampy woods and springy places, frequent.
- C. michelliana* M. A. Curtis.—Swampy woods and moist loamy ravines, 2, 5, 17, rare.
- C. muhlenbergii* Schkuhr.—Old fields and woods, 7, 11, rare.
- C. nigromarginata* Schwein.—Rich or rocky woods of the Red Hills, 11, 12, rare.
- C. oblita* Steud.—Boggy places, 11, 12, rare.
- C. oligocarpa* Schkuhr.—Rich woods, 12, 17, rare.
- C. oxylepis* Torr. & Hook.—Rich, moist woods, 12, 17, infrequent.
- C. physorhyncha* Liebm.—Rich, dry woods, in the Red Hills, 11, 12, 17, infrequent.
- C. retroflexa* Muhl.—Dry woods, 5, 12, 17, rare.
- C. straminea* Willd. (*C. richii* (Fern.) Mack.).—Near Leary in shallow water of a roadside marsh, 10, rare.
- C. striatula* Michx. (*C. laxiflora* of the *Manual*).—Rich, dry or moist, woods, mainly in the Red Hills, frequent.
- C. styloflexa* Buckley.—Rich, moist, loamy or dry, sandy woods, especially in the Red Hills, frequent.
- C. texensis* (Torr.) Bailey.—Dry woods, river banks, and grassy places, 5, 11, 12, rare.
- C. tribuloides* Wahl.—Wet ravine bottom near Fort Gaines, 11, rare.
- C. venusta* Dewey.—Near Blakley in moist woods along Breastworks Branch, 12, rare.
- C. verrucosa* Muhl.—Shallow water of cypress ponds and wet pinelands, frequent.
- C. vulpinoidea* Michx.—Reported by Harper (1900) from wet meadows, 1.
- C. walteriana* Bailey.—Shallow water of cypress ponds and wet pinelands, 7, 10, 12, 14, infrequent.
- C. willdenowii* Schkuhr.—Infrequent in rich or rocky woods of the Red Hills; rare in ravines in the escarpment, 5, 11, 12, 17.
- Cladium jamaicense* Crantz. (*Mariscus jamaicensis* (Crantz) Britt.).—Saw-grass.—Shallow water of cypress ponds near Leary, 10, rare.
- Cyperus brevifolius* (Rottb.) Hassk. (*Kyllinga brevifolia* Rottb.).—Ravine bottom in bluff near junction of Flint and Chattahoochee rivers, 17, rare.
- C. compressus* L.—Damp sand of moist pinelands, roadsides, and ditches, mostly on the Dougherty Plain, frequent.
- C. cuspidatus* HBK.—Sandy soil of cotton field near Waterfalls north of Whigham, 16, rare.
- C. densicaespitosus* Mattf. & Kük. (*Kyllinga pumila* Michx.).—Moist soil of pinelands,

pond and stream margins, ditches, and other wet places, frequent.

C. erythrorhizos Muhl.—Wet soil of pond margins and swamps, 9, 10, rare.

C. esculentus L. Chufa.—Sandy, cultivated fields and moist roadsides, 5, 7, 15, infrequent.

C. filiculmis Vahl. (incl. var. *macilentus* Fern.).—Dry, sandy soil, 5, 7, 9, 11, 14, infrequent.

C. flavescens L. (incl. var. *poaeformis* (Pursh) Fern.).—Moist, sandy places near Colquitt, 13, rare.

C. globulosus Aubl.—Sandy soil and waste places, frequent.

C. haspan L.—Common on the Dougherty Plain in moist pinelands and the wet margins of ponds; infrequent in wet places in the Red Hills.

**C. iria* L.—Wet, sandy roadsides, ditches, fields, and waste places, frequent.

C. martindalei Britt.—Dry, sandy, pine or oak woods, 14, 17, rare.

C. odoratus L. (incl. *C. ferax* L. C. Rich; *C. speciosus* Vahl).—Along or near the Chattahoochee River, 12, rare.

C. ovularis (Michx.) Torr.—Sandy pinelands and moist places, 1, 8, 10, 12, 13, 14, 18, infrequent.

C. pollardi Britt. (incl. *C. deeringianus* Britt. & Small).—Moist, sandy places, 7, 9, rare.

C. polystachyos Rottb. var. *texensis* (Torr.) Fern. (*C. microdontus* Torr., *C. paniculatus* Rottb.).—Moist ground, 9, 11, 12, 13, infrequent.

C. pseudovegetus Steud.—Moist pinelands, wet ditches, and pond margins, frequent.

C. retrofractus (L.) Torr. (incl. *C. hystricinus* Fern., *C. plukenetii* Fern.).—Dry, sandy fields and woods, common.

C. retrorsus Chapm. (incl. *C. torreyi* Britt.).—Sandy soil of pinelands, pond margins, ditches, and open fields, common.

**C. rotundus* L. Nut-grass.—Waste grounds, roadsides, and sandy fields, frequent.

C. strigosus L. (incl. *C. stenolepis* Torr.).—Wet places along streams, in moist pinelands, ditches, ravine bottoms, and swampy woods, common.

C. virens Michx.—Wet mud or sand of pond margins, 9, 12, 14, 17, infrequent.

Dichromena colorata (L.) Hitchc. Star-rush.—Moist, open grassy areas, on the Dougherty Plain, 7, 9, 10, 12, 14, infrequent.

D. latifolia Baldw. White-top-rush.—Moist pinelands and shallow water of wet pinelands and cypress ponds, 7, 10, 13, 15, infrequent.

Dulichium arundinaceum (L.) Britt.—Shallow water of cypress ponds, 7, 12, 13, 14, 17, infrequent.

Eleocharis acicularis (L.) R. & S.—Shallow water and wet margins of ponds, 7, 9, 12, 13, 14, 17, infrequent.

E. atropurpurea (Reitz.) J. & C. Presl.—Wet margins of ponds and borrow-pits, 7, 9, 12, 14, 17, 18, infrequent.

E. baldwinii (Torr.) Chapm. (incl. *E. prolifera* of the *Manual*).—Shallow water and wet, sandy margins of ponds, 12, 13, 17, 18, infrequent.

E. equisetoides (Ell.) Torr.—Shallow water of ponds, 1, 7, 10, 12, 13, 15, 17, infrequent.

E. flavescens (Poir.) Urban (*E. flaccida* (Reich.) Urban).—Wet places, 12, 14, 17, infrequent.

E. melanocarpa Torr.—Shallow water and wet margins of ponds, 7, 9, 17, rare.

E. microcarpa Torr. (incl. *E. torreyana* Boeckl., *E. brittonii* Svenson).—Moist pinelands and shallow water of borrow-pits and pineland ponds, frequent.

E. nodulosa (Roth) Schultes.—Small ponds, borrow-pits, and ditches, 12, 17, infrequent.

E. obtusa (Willd.) Schultes.—Moist pinelands and wet mud or sand of ponds, ditches, and borrow-pits, frequent.

E. quadrangulata (Michx.) R. & S.—Small ponds, 9, 13, rare.

E. robbinsii Oakes.—Shallow water of ponds, 1, 7, 12, 17, infrequent.

E. tortilis (Link) Schultes (*E. simplex* (Ell.) A. Dietr.).—Bogs and springy places in ravines, 11, 12, rare.

E. tricostrata Torr.—Shallow water and wet, sandy margins of ponds and wet, open grassy areas, frequent.

E. tuberculosa (Michx.) R. & S.—Wet sand of moist pinelands, bogs, and seepage slopes, frequent.

- E. vivipara* Link.—Wet margins of ponds, 9, 17, rare.
Fimbristylis autumnalis (L.) R. & S. (*F. geminata* (Nees) Kunth, *F. mucronulata* (Michx.) Blake).—Moist soil of pond margins, river banks, moist pinelands, and ditches, common.
F. baldwiniana (Schultes) Torr.—Moist, sandy roadsides and ditches, 9, 13, rare.
F. drummondii Boeckl. (*F. puberula* of the *Manual* in part).—Moist pinelands, open, grassy areas, and pond margins, frequent.
**F. miliacea* Vahl.—Ditches and banks of the Chattahoochee River, 12, 13, 18, rare.
F. perpusilla Harper.—“On the muddy bottom of a dried-up pine-barren pond near Leslie,” 1, the type-locality (Harper 1904). Not known anywhere else.
**F. schoenoides* Vahl.—Moist, sandy roadside through moist pinelands, 13, rare.
**F. sp.*—Wet sand of a small pond several miles east of Colquitt, 13. Probably an introduction from the tropics related to *F. diphylla* (Retz) Vahl. The achenes are more nearly orbicular and much more finely ridged (15-19) than the obovate, coarsely (7-9) ridged achenes of *F. diphylla*; and the plants are annual.
Fuirena breviseta Coville. Umbrella-grass.—Moist sand of pond margins, moist pinelands, and bogs, common.
F. squarrosa Michx. (*F. hispida* Ell.).—Moist, sandy or boggy places, 5, 10, 11, 13, 17, infrequent.
Lipocarpa maculata (Michx.) Torr.—Wet sand of moist pinelands, 7, 13, 14, infrequent.
Psilocarya corymbifera (C. Wright) Benth. Bald-rush.—Floating mats in Cane Water Pond, 17, rare.
P. nitens (Vahl) Wood.—Wet sand of shallow ponds, 14, rare.
Rhynchospora baldwinii A. Gray. Beak-rush.—Reported by Harper (1906) from 17, presumably in the Tifton Upland.
R. caduca Ell. (incl. *R. patula* A. Gray).—Wet, sandy pinelands, ditches, and shallow cypress ponds, frequent.
R. cephalantha A. Gray (*R. axillaris* sensu Britt.).—Moist pinelands and bogs, frequent.
R. chapmanii M. A. Curtis.—Moist pinelands, 10, 13, 17, rare.
R. ciliaris (Michx.) C. Mohr.—Moist pinelands and boggy areas, 10, 12, 13, 15, 17, infrequent.
R. compressa Carey.—Rolling pinelands west of Sylvester, 8, rare.
R. corniculata (Lam.) A. Gray.—Shallow water of ponds and swamps, common.
R. decurrens Chapm.—Moist pinelands and shallow water of cypress ponds, 9, 10, 13, infrequent.
R. divergens M. A. Curtis.—Moist pinelands, 9, 10, rare.
R. fascicularis (Michx.) Vahl (incl. *R. distans* (Michx.) Vahl, *R. wrightiana* Boeckl., *R. debilis* Gale).—Moist pinelands, frequent. A polymorphic species.
R. filifolia A. Gray.—Moist pinelands and wet margins of ponds, frequent.
R. globularis (Chapm.) Small (incl. *R. cymosa* of the *Manual*).—Moist pinelands, pond margins, and moist meadows, common.
R. glomerata (L.) Vahl (incl. *R. capitellata* (Michx.) Vahl, *R. leptocarpa* (Chapm.) Small).—Moist pinelands, bogs, and springy ravine bottoms and slopes, frequent.
R. gracilentia A. Gray.—Moist pinelands, 1, 6, 7, 8, 12, 17, infrequent.
R. grayii Kunth.—Dry, sandy pinelands and oak barrens, frequent.
R. harperi Small.—Moist pinelands, 1, 15, rare.
R. harveyi W. Boott (incl. *R. earlei* Britt.).—Dry pinelands, oak woods, and open grassy areas, frequent.
R. inexpansa (Michx.) Vahl.—Sandy pinelands and wet meadows, 1, 12, rare.
R. intermixta C. Wright.—Moist pinelands and open, grassy areas, 8, 13, 14, infrequent.
R. macrostachya Torr.—Swampy place near Leesburg, 7, rare.
R. megalocarpa A. Gray (*R. dodecandra* Baldw.).—Dry, sandy hammocks, 14, 17, rare.
R. microcephala Britt. (incl. *R. chalarocephala* Fern. & Gale).—Moist pinelands and bogs, 12, 13, rare.
R. miliacea (Lam.) A. Gray.—Swamps and springs, frequent.
R. mixta Britt. (incl. *R. prolifera* Small).—Swamps and wet woods, margins of ponds, streams, and springs, and springy ravine slopes, 1, 9, 14, 17, infrequent.

- R. oligantha* A. Gray.—Moist pinelands, 1, 8, rare.
R. perplexa Britt.—Moist pinelands, shallow ponds, and moist, open, grassy areas, frequent.
R. pleiantha (Kük.) Gale.—Margin of pine-barren pond near Rift, 7, (Gale 1944), rare.
R. plumosa Ell. (incl. *R. semiplumosa* A. Gray).—Moist pinelands, margins of cypress ponds, and open, grassy areas, frequent.
R. rariflora (Michx.) Ell.—Moist pinelands, 1, 10, 12, 13, 14, infrequent.
R. schoenoides (Ell.) Wood.—Moist pinelands and roadside ditches, 1, 12, 14, infrequent.
R. sulcata Gale.—Shallow, pineland ponds and sandy or boggy margins of permanent ponds, 13, 14, 17, infrequent.
R. torreyana A. Gray.—Moist pinelands, 13, 14, rare.
R. tracyi Britt.—Shallow water of wet pinelands and cypress ponds, frequent.
R. sp.—Collected only once in damp sand a mile or so from Mossy Pond, 14. The material collected of this small, capillary-leaved species does not match any described species. The achenes, usually two in a spikelet, are coarsely-pitted, lenticular, and about 1 mm long with a small tubercle and six antorsely-barbed bristles shorter than the achene.
Scirpus americanus Pers. Bulrush.—Reported only from Sumter County by Harper (1900).
S. atrovirens Willd. (incl. *S. georgianus* Harper).—Reported only from Sumter County by Harper (1900).
S. divaricatus Ell.—Alluvial swamps along streams on the Dougherty Plain, frequent.
S. etuberculatus (Steud.) Kuntze (*S. cylindricus* Britt.).—Permanent ponds, 1, 3, 17, (Harper 1905, 1906).
S. fontinalis Harper.—Known in southwestern Georgia only from the type locality, shallow margin of a shady pool of clear, cool water issuing from a spring, Leslie, 1, (Harper 1903).
S. hallii A. Gray.—Shallow intermittent ponds and sandy margins of permanent ponds, 9, 17, rare.
S. lineatus Michx.—Swamps, 10, 12, rare.
S. rubricosus Fern. (*S. eriophorum* Michx.). Wool-grass.—Swamps, marshes, ditches, and borrow-pits, common.
Scleria baldwinii (Torr.) Steud. (incl. *S. costata* (Britt.) Small). Nut-rush.—Moist pinelands and margins of cypress swamps, 1, 9, 10, 12, infrequent.
S. ciliata Michx. (incl. *S. brittonii* Core, *S. elliptica* Chapm.).—Dry, sandy pinelands, oak woods, and oak barrens on the Dougherty Plain, frequent.
S. georgiana Core (*S. gracilis* Ell., not Rich.).—Moist pinelands and open, grassy areas, 1, 7, 9, 10, 12, 13, 14, infrequent.
S. hirtella Sw.—Moist pineland 5 miles west of Sylvester, 8, rare.
S. mühlenbergii Steud. (*S. setacea* of the *Manual*).—Moist pinelands, 8, 10, 12, 13, 14, infrequent.
S. oligantha Michx.—Rich, rocky, or dry woods, 9, 11, 12, 17, infrequent.
S. pauciflora Muhl.—Moist pinelands and open grassy areas, 10, 13, 14, infrequent.
S. reticularis Michx.—Moist pinelands and shallow pineland ponds, 1, 14, rare.
S. triglomerata Michx. (incl. *S. nitida* Willd.).—Sandy pinelands, oak barrens, and moist thickets, 1, 7, 10, 14, 17, infrequent.
S. verticillata Muhl.—Moist pinelands, 1, 7, 10, 12, 14, 17, infrequent.
S. sp.—Moist pinelands one-half mile west of Pretoria, 9. This is a new species named and described by Dr. Core but not yet published.

PALMAE—Palm Family

Rhapidophyllum hystrix (Fraser) H. Wendl. Needle palm.—Frequent in swampy woods along streams and on the steep slopes of ravines and gorges, mostly in the Red Hills and northern part of the Dougherty Plain; infrequent in steepheads (heads of ravines) and deep limesinks along the escarpment.

Sabal minor (Jacq.) Pers. Blue-stem.—Swampy woods and bottomlands along streams, common.

Serenoa repens (Bartr.) Small. Saw-palmetto.—Sandy banks of streams, sandy oak barrens, and moist, sandy pinelands, 9, 12, 14, 15, 17, infrequent.

ARACEAE—Arum Family

Arisaema dracontium (L.) Schott. Green-dragon.—Moist, rich woods and bottoms along streams, frequent.

A. quinatum (Nutt.) Schott.—Rich, loamy, wooded ravine slopes, 5, 11, rare.

A. triphyllum (L.) Schott ssp. *triphyllum* (*A. atrorubens* (Ait.) Blume). Jack-in-the-pulpit.—Moist, rich woods, frequent.

A. triphyllum (L.) Schott ssp. *pusillum* (Peck) Huttleston (*A. pusillum* (Peck) Nash, *A. acuminatum* Small).—Frequent in moist to swampy woods; infrequent on rich, loamy ravine slopes.

Orontium aquaticum L. Golden-club, Never-wet.—Swamps and bogs in the Red Hills and northwestern part of the Dougherty Plain, frequent.

Peltandra virginica (L.) Schott & Endl. Wake-robin, Green Arum.—Frequent in swamps and bogs, often with *Orontium*; not seen on the Dougherty Plain south of 12 and 14.

LEMNACEAE—Duckweed Family

Lemna perpusilla Torr. Duckweed.—Pool in the desiccated bed of Dry Creek 6 miles northwest of Colquitt, 13, rare.

L. valdiviana Philippi (*L. cyclostasa* C. H. Thompson).—Ponds, 12, 14, infrequent.

Spirodela polyrrhiza (L.) Schleid. Large duckweed.—Ponds and swamps, 9, 12, 17, infrequent.

Wolffia papulifera C. H. Thompson.—Ponds and swamps, 12, 17, rare.

Wolffiella floridana (J. D. Smith) C. H. Thompson.—Shallow water of ponds on the Dougherty Plain, 12, 13, 14, 17, infrequent.

MAYACACEAE—Bog-moss Family

Mayaca aubletii Michx. Bog-moss.—Bogs and wet, sandy margins of ponds, frequent.

M. fluviatilis Aubl.—Shallow water of ponds and borrow-pits, 12, 17, 18, infrequent.

XYRIDACEAE—Yellow-eyed-grass Family

Xyris ambigua Beyr. Yellow-eyed-grass, hard-head.—Moist pinelands and bogs, frequent.

X. baldwiniana Schultes. St. Mary's grass.—Moist pinelands, 1, 10, 13, 17, infrequent.

Xyris caroliniana Walt.—Wet places, especially moist pinelands, pond margins, and open, grassy areas, frequent.

X. curtisii Malmé (*X. neglecta* Small, not Nilsson).—Moist pinelands and bogs, 12, 13, 17, infrequent.

X. elliotii Chapm.—Wet sand, 12, 13, rare.

X. fimbriata Ell.—Cypress ponds, wet pinelands, and bogs, frequent.

X. flabelliformis Chapm.—Moist pinelands and boggy areas, 10, 12, 13, 17, infrequent.

X. flexuosa Muhl. (incl. *X. pallescens* (C. Mohr) Small).—Moist pinelands and bogs, frequent.

X. iridifolia Chapm.—Cypress ponds, wet pinelands, and bogs, 7, 10, 12, 13, 14, infrequent.

X. jupicæ Rich. (incl. *X. communis* Kunth, *X. elata* Chapm., *X. difformis* Chapm.)—Moist pinelands, wet margins and shallow water of ponds, marshy ground along streams, bogs, and wet places generally, common.

X. platylepis Chapm.—Moist pinelands and bogs, 5, 7, 10, 11, 12, 13, 17, infrequent. This species appears to intergrade with the *X. jupicæ* complex and may not be specifically distinct from it.

X. serotina Chapm.—Moist pinelands 11 miles northwest of Colquitt, 12, rare.

X. smaliana Nash.—Cypress and permanent ponds, 3, 10, 12, 13, 14, 17.

ERIOCAULACEAE—Pipewort Family

Eriocaulon compressum Lam. Pipewort.—Wet pinelands and cypress ponds, frequent.

E. decangulare L.—Moist pinelands, cypress ponds, and bogs, common.

E. septangulare With. (incl. *E. lineare* Small).—Shallow water and wet margins of ponds and borrow-pits and moist pinelands, frequent. Our material may be separable from the more northern typical *E. septangulare* as a subspecies.

Lachnocaulon anceps (Walt.) Morong. Hairy pipewort.—Wet sand of moist pinelands, seepage slopes, and bogs, frequent.

L. minus (Chapm.) Small.—Margins of ponds and open, grassy or boggy areas, 12, 14, infrequent.

Syngonanthus flavidulus (Michx.) Ruhl.—Moist pinelands and boggy areas, 12, 13, 17, rare.

COMMELINACEAE—Spiderwort Family

Commelina caroliniana Walt.—Moist sandy soil near the headwaters of Willacoochee Creek, 3 miles northeast of Faceville, 17, rare.

**C. communis* L.—Weedy backyard in Albany, 9, rare.

C. diffusa Burm. f. (*C. longicaulis* Jacq.).—Moist places near streams, 12, 13, 17, infrequent.

C. erecta L. (incl. *C. angustifolia* Michx.).—Dry, sandy pinelands and oak woods, 5, 7, 9, 10, 14, 17, infrequent.

C. virginica L.—Moist or swampy woods and bottomlands along streams, especially along the Chattahoochee River, common.

**Tradescantia fluminensis* Vell.—Bluffs along the Chattahoochee River, 11, rare.

T. ohienensis Raf. (*T. reflexa* Raf., *T. canaliculata* Raf.).—Dry pinelands, oak woods, and sandy barrens, frequent.

T. subaspera Ker-Gawl. var. *montana* (Shutlw.) Anders. & Woods. (*T. pilosa* of the Manual in part).—Rich wooded bluff near the Chattahoochee River below Hilton, 12. (Anderson and Woodson, 1935).

PONTEDERIACEAE—Pickerel Weed Family

**Eichornia crassipes* (Mart.) Solms. Water-hyacinth. (*Piaropus crassipes* (Mart.) Britt.).—Established in an artificial pond near a refrigeration plant outside Camilla, 15, rare.

Pontederia cordata L. (incl. *P. lanceolata* Nutt.). Pickerel weed.—Ponds and wet pinelands, common.

BROMELIACEAE—Pineapple Family

Tillandsia usneoides L. (*Dendropogon usneoides* (L.) Raf.). Spanish-moss.—Abundant epiphyte on trees.

JUNCACEAE—Rush Family

Juncus acuminatus Michx. Rush.—Moist open places, especially ditches and shallow water of small ponds and swamps, 7, 9, 14, 17, infrequent.

J. biflorus Ell. (*J. aristulatus* of authors, not Michx.).—Moist pinelands and open, marshy places, frequent.

J. canadensis J. Gay.—Boggy swamp 2 miles south of Hilton, 12, rare.

J. coriaceus Mack. (*J. setaceus* of authors, not Rostk.).—Ravine bottoms, spring ravine slopes, and sandy swamps along streams, frequent.

J. debilis A. Gray.—Wet, sandy or boggy places, 11, 12, 13, 17, infrequent.

J. dichotomus Ell. (*J. tenuis* of recent authors).—Moist, sandy soil, especially in moist pinelands, ditches, and margins of ponds and streams, frequent.

J. effusus L. (incl. varieties).—Swampy or marshy places, common.

J. elliotii Chapm.—Damp sand of moist pinelands, ditches, borrow-pits, and open, grassy places, frequent.

J. marginatus Rostk.—Moist places, frequent.

J. megacephalus M. A. Curtis.—Moist pinelands and wet margins of ponds, 7, 9, 10, 13, 14, infrequent.

J. polycephalus Michx.—Shallow water of cypress ponds, swamps, and wet pinelands, frequent.

J. repens Michx.—Shallow water and wet margins of ponds and sluggish streams, common.

J. scirpoides Lam.—Moist pinelands, shallow, grassy ponds, and borrow-pits, common.

J. tenuis Willd. (*J. macer* S. F. Gray).—Roadsides, waste ground, and moist places, 10, 11, 12, 14, 17, infrequent.

J. trigonocarpus Steud.—Bogs and springy ravine slopes, 1, 5, 11, 12, 17, infrequent.

Luzula acuminata Raf. (*Juncoides saltuense* (Fern.) Small). Wood-rush.—Moist, rich, loamy woods of ravines, 5, 11, 12, 17, infrequent.

L. echinata (Small) F. J. Herm. (*Juncoides echinatum* Small).—Rich, loamy woods of ravines and bluffs, 3, 5, 11, 12, 17, infrequent.

ROXBURGHIAEAE—Roxburghia Family

Croomia pauciflora (Nutt.) Torr. *Croomia*.—Rich, loamy woods of ravines and bluffs near the Chattahoochee River, 4, 11, 17, rare.

LILIACEAE—Lily Family

Aletis aurea Walt. Colic root.—Moist pinelands, frequent.

A. farinosa L.—Dry pinelands and oak woods, 9, 10, 14, infrequent.

Allium canadense L.—Wild onion, meadow leek.—Near the railroad terminal and on a roadside in Fort Gaines, 11, rare.

A. microscordium Small.—Dry oak or pine woods and sandy roadsides, 9, 10, 12, 14, infrequent.

**A. vineale* L. Wild garlic.—Lawns, fields, and roadsides, 1, 5, 9, infrequent.

Amianthium muscaetoxicum (Walt.) A. Gray (*Chrosperma muscaetoxicum* (Walt.) Kuntze) Fly-poison.—Bogs, seepage slopes, and acid, wooded ravine slopes, 12, 17, rare.

**Asparagus officinalis* L. *Asparagus*.—Waste places and roadsides, 1, 9, 18, infrequent.

Chamaelirium luteum (L.) A. Gray. Fairy wand.—Infrequent in the Red Hills and along the escarpment in rich woods of ravines; infrequent on the Dougherty Plain in pinelands and moist woods; 5, 7, 9, 10, 11, 12, 17.

Erythronium americanum Ker. Adder's tongue, amberbell.—Rich woods of ravines and bluffs, 5, 12, 17, rare.

**Hemerocallis fulva* L. Day-lily.—Roadsides between Blakely and Fort Gaines, 11, 12, rare.

Lilium catesbaei Walt. Pine Lily.—Moist pinelands, 1, 7, 10, 12, infrequent.

L. michauxii Poir. (*L. carolinianum* Michx., not Bosc). Turk's-cap-Lily.—Rich, moist or dry woods in the Red Hills and along the escarpment, frequent.

L. superbum L. Lily royal.—Moist, open ground and moist woods, 1, 8, 9, 10, infrequent.

Medeola virginiana L. Indian cucumber-root.—Rich, moist woods of the Red Hills, 5, 12, rare.

Melanthium virginicum L. Bunch flower.—Moist pinelands and bogs, 1, 9, 10, 12, 14, infrequent.

Nothoscordum bivalve (L.) Britt. False-garlic.—Open woods, fields, and roadsides, common.

Polygonatum biflorum (Walt.) Ell. (incl. *P. commutatum* (R. & S.) Dietr., but not *P. biflorum* of the Manual). Solomon's-seal.—Rich woods, frequent.

Smilacina racemosa (L.) Desf. (*Vagnera racemosa* (L.) Morong, *Vagnera australis* Rydb.). False Solomon's-seal.—Rich woods in the Red Hills, frequent.

Smilax auriculata Walt. Wild-bamboo.—Dry, sandy oak barrens, pinelands, and thickets on the Dougherty Plain, 7, 9, 12, 14, 17, infrequent.

S. bona-nox L. Bamboo, chinabrier, bullbrier.—Many habitats, especially along streams, in hammocks, ravines, and thickets, abundant.

S. ecirrhata (Engelm.) Wats. (*Nemexia ecirrhata* (Engelm.) Small).—Dry oak woods a few miles north of Smithville, 1, rare.

S. glauca Walt. Wild-sarsaparilla, sawbrier.—Wide range of habitats, usually in sandy soil, abundant.

S. herbacea L. (incl. *Nemexia herbacea* (L.) Small, *N. biltmoreana* Small, *N. lasioneuron* (Hook.) Rydb.). Carrion flower.—Rich woods along streams and in ravines, common.

S. hispida Muhl. var. *australis* J. B. Norton. Greenbrier.—Moist woods and thickets along streams and in ravines, common.

S. hispida Muhl. var. *hispida*. Greenbrier.—Rich, usually moist woods of ravines in the Red Hills, frequent.

S. hugeri (Small) J. B. Norton (*Nemexia hugeri* Small).—Rich, loamy, wooded slopes of ravines in the Red Hills, 5, 11, 12, infrequent.

S. laurifolia L. Blaspheme vine, bamboo.—Sandy swamps, bogs, seepage slopes, wet pinelands, cypress ponds, and swampy woods along streams, common.

S. pumila Walt. Sarsaparilla vine.—Hammocks and dry or rich woods of ravines and bluffs, usually in association with *Mitchella repens* L., common.

S. rotundifolia L. Greenbrier, catbrier.—Wide variety of habitats, especially stream or pond margins, woods, and thickets, common.

S. smallii Morong (*S. lanceolata* of authors, not L.).—Sandy or rich woods, usually on rocks or bluffs along streams or in ravines, common.

S. walteri Pursh. Sarsaparilla, coral greenbrier.—Climbing on trees and shrubs in cypress ponds, sandy swamps, bogs, and wet pinelands, common.

Stenanthium gramineum (Ker) Morong (incl. var. *micranthum* Fern. and var. *robustum* (S. Wats.) Fern., *S. robustum* S. Wats.). Featherbell.—Sandy soil, 8, 10, rare.

Tofieldia racemosa (Walt.) B.S.P. (*Triantha racemosa* (Walt.) Small). Wood featherling.—Moist pinelands and open, boggy places, frequent.

Trillium catesbaei Ell. Rosy wake-robin.—Rich woods in the Red Hills, 2, 11, 12, infrequent.

T. lancifolium Raf. (*T. lanceolatum* Boykin).—Moist, loamy slopes of ravines in bluff north of Chattahoochee, Florida, 17, rare.

T. sessile L. (southern subspecies incl. *T. hugeri* Small, *T. underwoodii* Small). Toadshade.—Rich woods, frequent.

T. vaseyi Harbison.—Rich woods of ravines near Cuthbert, 5, rare.

Uvularia floridana Chapm. (*Oakesiella floridana* (Chapm.) Small). Merry bells.—Moist or swampy woods and sandy bogs, 2, 5, 10, 12, infrequent.

U. perfoliata L. Straw-bell, bellwort.—Rich woods of ravines and bluffs, frequent.

Veratrum intermedium Chapm. False-hellebore.—Rich, loamy, wooded ravine slopes in the Red Hills, 11, 12, rare.

**Yucca aloifolia* L. Spanish bayonet.—Old fields and roadsides, infrequent; perhaps not spontaneous, 1, 10, 14.

Y. smalliana Fern. (*Y. filamentosa* of authors, not L.). Bear-grass.—Dry places, common.

Zygadenus densus (Desr.) Fern. (*Tracyanthus angustifolius* (Michx.) Small). Crow-poison.—Open, boggy area near the headwaters swamp of Willacoochee Creek northeast of Faceville, 17, rare.

Z. glaberrimus Michx.—Sandy bogs, 1, 17, rare.

HAEMODORACEAE—Bloodwort Family

Lachnanthes tinctoria (Walt.) Ell. (*Gyrotheca tinctoria* (Walt.) Salisb.). Redroot.—Moist pinelands, frequent.

AMARYLLIDACEAE—Amaryllis Family

Agave virginica L. (*Manfreda virginica* (L.) Salisb.). Rattlesnake-master.—Dry, sandy woods, frequent.

Hymenocallis occidentalis (Le Conte) Kunth. Spider-lily.—Swamps, bottomlands, moist, rich woods of ravine bottoms and slopes, common.

Hypoxis hirsuta (L.) Coville. Star-grass.—Dry woods on loamy or clayey ravine slopes in the Red Hills, 1, 3, 5, 11, infrequent.

H. juncea J. E. Smith.—Moist pinelands and open boggy areas, 10, 12, 13, 17, infrequent.

H. leptocarpa Engelm.—Swampy or rich, moist woods along streams and on ravine slopes, 5, 7, 10, 13, 14, 17, infrequent.

H. micrantha Pollard.—Dry ravine slope of bluff one mile north of Chattahoochee, Florida, 17, rare.

H. rigida Chapm.—Pinelands, 14, rare.

Zephyranthes atamasco (L.) Herb. (*Atamosco atamasco* (L.) Greene). Easter-lily.—Rich woods and low, open ground, frequent.

**Z. candida* (Lindl.) Herb. (*Atamosco candida* (Lindl.) Small).—Sandy field 4 miles south of Damascus, 13, rare.

DIOSCOREACEAE—Yam Family

Dioscorea villosa L. (incl. *D. quaternata* (Walt.) J. F. Gmel., *D. hirticaulis* Bartlett, *D. floridana* Bartlett). Wild yam-root.—Woods and thickets, common.

IRIDACEAE—Iris Family

Iris hexagona Walt. Blue flag.—Swamps along streams, wet pinelands, and spring heads, 9, 10, 14, infrequent.

I. verna L. (*Neubeckia verna* (L.) Alef., *I. verna* L. var. *smalliana* Fern.).—Dwarf iris, violet iris.—Dry woods in the Red Hills, 5, 11, 12, infrequent.

I. virginica L. Southern blue flag.—Swamps, ditches, and stream and pond margins on the Dougherty Plain, frequent.

Sizyrinchium angustifolium Mill. (*S. graminoides* Bicknell). Blue-eyed grass.—Rich woods in the Red Hills, 5, 11, 12, infrequent.

S. arenicola Bicknell (incl. *S. fibrosum* Bicknell, *S. floridanum* Bicknell).—Dry, sandy, open pine or oak woods, frequent.

S. atlanticum Bicknell.—Moist pinelands and wet, open places, 10, 12, 13, 14, 18, infrequent.

S. rosulatum Bicknell.—Wet, sandy soil near the headwaters swamp of Willacoochee Creek, 3 miles northeast of Faceville, 17, rare.

CANNACEAE—Canna Family

**Canna indica* L. Indian-shot.—Overrunning a peanut-hull dump at the edge of a swamp on the outskirts of Blakely, 12, rare.

BURMANNIACEAE—Burmanna Family

Aptera aphylla (Nutt.) Barnh. Nodding-nixie.—Moist woods, 11, 12, 16, rare.

Burmanna biflora L.—Moist pinelands, 1, 10, rare.

B. capitata (Walt.) Mart.—Moist pinelands, 8, 10, 13, 17, infrequent.

ORCHIDACEAE—Orchid Family

Calopogon barbatus (Walt.) Ames (*Limodorum parviflorum* (Lindl.) Nash). Grass-pink.—Moist pinelands, 10, 12, 13, 17, infrequent.

C. pallidus Chapm. (*Limodorum pallidum* (Chapm.) C. Mohr).—Open wet pinelands north of Leesburg, 7, rare.

C. pulchellus (Salisb.) R. Br. (*Limodorum tuberosum* L.).—Moist pinelands, 1, 7, 10, 13, 14, 17, infrequent.

Cleistes divaricata (L.) Ames. Lady's ettercap, rose orchid.—Moist pinelands and open, boggy areas, 3, 12, 13, infrequent.

Coralorrhiza wisteriana Conrad. Coral root.—Sandy hammocks and rich woods, frequent.

Epidendrum conopseum R. Br. (*Amphiglottis conopsea* (R. Br.) Small). Green-fly orchid.—Common epiphyte on magnolia, beech, and live oak in hammocks, swampy woods, bottomlands, and stream banks in the southern half of the area; not observed north of 9, 10, 12. Observed also on *Magnolia virginiana*, *Acer barbatum*, and *Carya aquatica*.

Eulophia ecristata (Fern.) Ames (*Triorchos ecristatus* (Fern.) Small).—Dry, rolling pinelands near Dry Creek, 8, rare.

Habenaria blephariglottis (Willd.) Hook. (*Blephariglottis blephariglottis* (Willd.) Rydb., *B. conspicua* (Nash) Small). White-fringed orchid.—Moist pinelands and bogs, 1, 12, 17, infrequent.

x *H. chapmanii* (Small) Ames (*Blephariglottis chapmanii* Small).—Moist, cut-over pinelands near Leary, 10, rare.

H. ciliaris (L.) R. Br. (*Blephariglottis ciliaris* (L.) Rydb.). Yellow-fringed orchid.—Moist pinelands and bogs, frequent.

H. clavellata (Michx.) Spreng. (*Gymnadeniopsis clavellata* (Michx.) Rydb.). Green rein orchid.—Wet woods, sandy swamps, and bogs, 1, 10, 12, infrequent.

H. cristata (Michx.) R. Br. (*Blephariglottis cristata* (Michx.) Raf.). Golden-fringed orchid.—Bogs, wet, sandy woods, and moist pinelands, 1, 5, 10, 12, 17, infrequent.

H. flava (L.) R. Br. (*Perularia flava* (L.) Farwell, *P. scutellata* (Nutt.) Small, *P. bidentata* (Ell.) Small. Gypsy spike.—Moist woods along streams, 1, 8, 10, 12, infrequent.

H. integra (Nutt.) Spreng. (*Gymnadeniopsis integra* (Nutt.) Rydb.). Orange rein orchid.—Moist or boggy pinelands, 7, 17, rare.

H. nivea (Nutt.) Spreng. (*Gymnadeniopsis nivea* (Nutt.) Rydb.). Bog-torch, white rein orchid.—Moist pinelands, 1, 7, 10, 12, 13, 14, infrequent.

H. quinqueseta (Michx.) Sw.—Dry pinelands, 8, 12, rare.

H. repens Nutt.—On logs floating awash in Mossy Pond, 14, rare.

Hexalectris spicata (Walt.) Barnhart. Brunetta.—Rich, dry woods, 1, 5, 11, 12, 17, infrequent.

- Isotria verticillata* (Willd.) Raf. Green adderling.—Rich, moist woods, 5, 12, rare.
Malaxis unifolia Michx. Adder's mouth.—Rich or acid woods, 5, 11, rare.
Pogonia ophioglossoides (L.) Ker-Gawl. Etter-cap.—Moist pinelands and bogs, 1, 10, 12, infrequent.
Ponthieva racemosa (Walt.) C. Mohr. Shadow-witch.—Rich, moist woods and sandy swamps, 1, 9, 10, 11, 12, 14, infrequent.
Spiranthes cernua (L.) L. C. Rich. (*Ibidium cernuum* (L.) House). Ladies' tresses.—Alluvial or sandy swamps, 9, 12, rare.
S. grayi Ames (*Ibidium beckii* of the *Manual*).—Dry, sandy or clayey soil, 11, 12, 14, rare.
S. lacera Raf. (*Ibidium floridanum* Wherry, *I. gracile* (Bigel.) House).—Sandy pinelands and open, grassy areas, 13, 14, 17, infrequent.
S. laciniata (Small) Ames (*Ibidium laciniatum* (Small) House).—Shallow water of cypress ponds, grassy limesink ponds, and moist, open grassy areas, 1, 10, 14, rare.
S. ovalis Lindl. (*Ibidium ovale* (Lindl.) House).—Moist woods and swamps, 10, 12, 14, rare.
S. praecox (Walt.) S. Wats. (*Ibidium praecox* (Walt.) House).—Frequent in a variety of habitats: rich woods, moist pinelands, sandy hammocks, boggy areas, and intermittent pineland ponds.
S. vernalis Engelm. and Gray (*Ibidium vernale* (Engelm. & Gray) House).—Moist pinelands and open, grassy areas, 10, 11, 13, 14, infrequent.
Tipularia discolor (Pursh) Nutt. (*T. unifolia* (Muhl.) B. S. P.).—Rich woods, frequent.

SAURURACEAE—Lizard's-tail Family

Saururus cernuus L. Lizard's-tail.—Cypress ponds, swamps, and wet woods, common.

SALICACEAE—Willow Family

- **Populus alba* L. Silver poplar.—Rare on roadsides; probably not spontaneous, 14.
P. deltoides Bartt. (*P. balsamifera* of authors, not L.). Cottonwood, Carolina poplar.—Stream margins, common.
Salix caroliniana Michx. (*S. longipes* Anders., *S. amphibia* Small). Willow.—Stream margins on the Dougherty Plain, frequent.
S. floridana Chapm. (*S. chapmanii* Small).—Swampy or boggy woods in the vicinity of Hilton and Cedar Springs, 12, rare.
S. herbisonii Schneider.—Along Ichawaynochaway Creek near junction with Flint River, 14, rare.
S. nigra Marsh. Black willow.—Swamps and stream and pond margins, abundant.
S. rigida Muhl. (*S. cordata* Muhl.).—Stream margins, 4, 11, rare.
S. tristis Ait. Upland willow.—Dry, sandy thicket near Muckalee Creek, 3 miles north of Albany, 7, rare.

MYRICACEAE—Bayberry Family

- Myrica cerifera* L. (*Cerothamnus ceriferus* (L.) Small). Wax-myrtle.—Swamps, pond margins, hammocks, wet ravines, bogs, and along streams, common.
M. heterophylla Raf. (*Cerothamnus carolinensis* of the *Manual* in part).—Sandy swamps, bogs, and seepage slopes in the Red Hills and along the escarpment, frequent.
M. pusilla Raf. (*Cerothamnus pumilus* (Michx.) Small). Dwarf wax-myrtle. Flat, poorly drained pinelands, 1, 7, 10, 12, 15, 17, infrequent.

JUGLANDACEAE—Walnut Family

- Carya aquatica* (Michx. f.) Nutt. (*Hicoria aquatica* (Michx. f.) Britt.) Water hickory.—Stream margins, common.
C. cordiformis (Wang.) K. Koch (*Hicoria cordiformis* (Wang.) Britt.). Bitternut hickory.—River banks and bottoms and rich woods, especially along the Chattahoochee River, frequent.
C. glabra (Mill.) Sweet (*Hicoria glabra* (Mill.) Britt., *H. austrina* Small). Pignut.—Dry woods, very common.
**C. illinoensis* (Wang.) K. Koch (*Hicoria pecan* (Marsh.) Britt.). Pecan.—An occasional escape near pecan orchards and on river banks or bottoms.
C. ovata (Mill.) K. Koch (*Hicoria ovata* (Mill.) Britt.). Shagbark hickory.—Rich,

alluvial bottom woods (Rattlesnake Bottoms) between Flint River and Ichawaynochaway Creek just above their junction, 14.

C. pallida (Ashe) Engl. & Graebn. (*Hicoria pallida* Ashe). Pale hickory.—Road bank in swamp at Nine Bridges on Muckalee Creek, 7, rare.

C. tomentosa (Lam.) Nutt. (*Hicoria alba* (L.) Britt.). Mockernut.—Dry woods, common.

Juglans nigra L. (*Wallia nigra* (L.) Alef.). Black walnut.—Frequent on the banks of the Chattahoochee River; infrequent in rich woods elsewhere.

CORYLACEAE—Hazelnut Family

Alnus serrulata (Ait.) Willd. (*Alnus rugosa* of the *Manual*). Green alder.—Sandy swamps, bogs, seepage slopes, and stream margins, common.

Betula nigra L. River birch.—Stream margins, common.

Carpinus caroliniana Walt. Blue-beech, hornbeam.—Moist hammocks and moist or swampy woods along streams, common.

Corylus americana Walt. American hazelnut.—Moist woods along Fowltown Creek near the Armena lime quarry, 7, rare.

Ostrya virginiana (Mill.) K. Koch. Hop hornbeam.—Rich woods of hammocks, bluffs, and ravines, common.

FAGACEAE—Beech Family

Castanea dentata (Marsh.) Borkh. Chestnut.—Dry, loamy, wooded ravine slopes in the Red Hills, 5, 11, rare.

C. pumila (L.) Mill. (incl. *C. ashei* Sudw.). Chinquapin.—Dry, sandy or loamy woods, common.

Fagus grandifolia Ehrh. var. *caroliniana* (Loud.) Fern. & Rehd. Red beech.—Sandy or loamy, moist or dry woods of bluffs, ravines, bottoms, river banks, and hammocks, common.

Quercus alba L. White oak.—Moist or dry woods of bluffs, ravines, river bottoms and banks, and hammocks, usually with *Fagus grandifolia caroliniana* and *Magnolia grandiflora*, very common.

Q. austrina Small. Bluff oak.—Rich woods of river banks and bottoms, ravine slopes, and hammocks, 1, 7, 9, 12, 17, infrequent.

Q. coccinea Muenchh. Scarlet oak.—Dry wooded slopes in the Red Hills, 5, 11, 12, rare.

Q. durandii Buckl. Bastard white oak.—Calcareous woods along streams and on wooded slopes, 1, 7, 9, 10, 12, infrequent.

Q. falcata Michx. (*Q. rubra* of authors, not L., *Q. digitata* (Marsh.) Sudw., *Q. pagoda* Raf.). Southern red oak, Spanish oak.—Abundant in dry woods; infrequent in bottom woods.

Q. hemisphaerica Bartr. (*Q. laurifolia* of authors, not Michx.). Laurel oak.—Sandy hammocks and dry woods of stream banks, bluffs, and ravine crests, common.

Q. incana Bartr. (*Q. cinerea* Michx.). Upland willow oak, blue jack.—Very dry, sandy oak woods, oak barrens, and pinelands, common.

Q. laevis Walt. (*Q. catesbaei* Michx.). Turkey oak.—Dry, sandy oak barrens and pinelands, common.

Q. laurifolia Michx. (*Q. obtusa* (Willd.) Ashe, *Q. rhombica* Sarg.).—Moist or swampy woods and rich bottomlands along streams, frequent.

Q. lyrata Walt. Swamp white oak, overcup oak.—Alluvial swamps and wet bottomlands along streams on the Dougherty Plain, common.

Q. marilandica Muenchh. Black jack.—Dry, sandy or clayey woods, common.

Q. margareta Ashe. Small post oak.—Dry, sandy oak and pine woods, common; often in association with *Q. stellata* Wang., to which it is closely related.

Q. michauxii Nutt. (*Q. prinus* of authors, not L.). Cow oak, basket oak.—Alluvial swamps, wooded bottoms, and moist hammocks, common.

Q. minima (Sarg.) Small (*Q. virginiana* Mill. var. *dentata* (Chapm.) Sarg.). Dwarf live oak.—Flat, poorly drained pinelands, 10, 12, 13, 14, 15, infrequent.

Q. muehlenbergii Engelm. Chestnut oak, yellow oak.—Rich, calcareous woods, 5, 7, 11, 12, 17, infrequent.

Q. nigra L. Water oak.—Moist, sandy or alluvial woods, abundant.

Q. phellos L. Willow oak.—Moist woods on pond margins and along streams, 1, 5, 9, 17, infrequent.

Q. prinus L. (*Q. montana* Willd.). Chestnut oak.—Dry slopes of Providence Canyons, where it grows in abundance, 3, rare.

Q. pumila Walt. Runner oak.—Common in dry, sandy oak and pine woods in the southernmost counties, 15, 17, 18.

Q. rubra L. (*Q. borealis* Michx. var. *maxima* Ashe). Red oak.—Rich woods on ravine slopes in the Red Hills, 3, 5, 11, rare.

Q. shumardii Buckl. Shumard's oak.—Rich woods of moist hammocks, alluvial bottoms, river banks, and bluffs, common.

Q. stellata Wang. Post oak.—Dry, usually sandy, woods, common.

Q. velutina Lam. Black oak.—Dry, rich woods, frequent.

Q. virginiana Mill. Live oak.—Sandy soil around ponds, along streams, in hammocks, and in open woods on the Dougherty Plain, abundant.

Q. virginiana Mill var. *maritima* (Chapm.) Sarg. (*Q. geminata* Small). Twin live oak.—Sandy banks and dry, sandy hammocks along the Flint River and lower parts of Ichawaynochaway and Kinchafoonee creeks, 7, 14, 17, infrequent.

ULMACEAE—Elm Family

Celtis laevigata Willd. (*C. mississippiensis* Bosc). Hackberry.—Common in rich woods of stream banks and bottoms; less frequent on slopes and in open woods near ponds.

C. tenuifolia Nutt. var. *georgiana* (Small) Fern. & Schub. (*C. georgiana* Small, *C. pumila* Pursh var. *georgiana* Sarg.). Dwarf hackberry.—Dry, sandy or rich woods, often along streams, very common.

Planera aquatica (Walt.) J. F. Gmel. Water-elm.—Common on the margins of Flint River and Spring Creek and ponds with considerable fluctuation in water level, often standing in shallow water for months; apparently absent from the inner part of the Dougherty Plain and from the Red Hills.

Ulmus alata Michx. Winged elm.—Stream banks and bottoms, common.

U. americana L. American elm.—Common along streams on banks and in sloughs and bottoms; rare on pond margins.

U. rubra Muhl. (*U. fulva* Michx.).—Slippery elm.—Rich calcareous woods, frequent.

MORACEAE—Mulberry Family

**Broussonetia papyrifera* (L.) Vent. (*Papyrius papyrifera* (L.) Kuntze). Paper-mulberry. Roadsides and fields, frequent.

**Maclura pomifera* (Raf.) Schneid. (*Toxylon pomiferum* Raf.). Osage-orange.—Roadsides and dry woods, 5, 15, rare.

Morus rubra L. Red mulberry.—Rich, moist woods, generally along streams, common.

URTICACEAE—Nettle Family

Boehmeria cylindrica (L.) Sw. (incl. *B. drummondiana* Wedd.). False nettle.—Moist or swampy woods, common.

Laportea canadensis (L.) Wedd. (*Urticastrum divaricatum* (L.) Kuntze). Wood nettle.—Rich woods and bottoms along the Chattahoochee River, 12, 17, rare.

Pilea pumila (L.) A. Gray (*Adicea pumila* (L.) Raf.). Clearweed.—Moist, rich, shady woods, 5, 11, 12, rare.

LORANTHACEAE—Mistletoe Family

Phoradendron flavescens (Pursh) Nutt. Mistletoe.—Common parasite on deciduous trees, especially on *Nyssa sylvatica biflora*.

ARISTOLOCHIACEAE—Birthwort Family

Aristolochia serpentaria L. (incl. *A. hastata* Nutt.). Virginia snakeroot.—Common in rich, moist woods; rare in dry oak-pine woods.

A. tomentosa Sims. Pipevine.—Wooded banks of the Chattahoochee and Flint rivers, frequent.

Asarum arifolium Michx. (*Hexastylis arifolia* (Michx.) Small). Wild-ginger.—Rich woods in the Red Hills, frequent.

A. shuttleworthii Britten & Baker (*Hexastylis shuttleworthii* (Britten & Baker) Small).—Small, sandy swamp near Americus, 1, rare.

POLYGONACEAE—Buckwheat Family

(**Antigonon leptopus* H. & A. (*Corculum leptopus* (H. & A.) Stuntz). Coral-vine.—Vacant lot near the railroad station in Albany, 9, where it appeared to be spontaneous.)

Brunnichia cirrhosa Gaertn. Eardrop, buckwheat vine.—Stream banks, frequent.

Eriogonum tomentosum Michx. Wild-buckwheat.—Dry, sandy oak-pine woods, mostly on the Dougherty Plain, common.

Polygonella gracilis (Nutt.) Meisn. (*Delopyrum gracile* (Nutt.) Small, *D. filiforme* Small). Jointweed, wireweed.—Dry, sandy oak barrens and pinelands, 9, 11, 14, 15, 17, infrequent.

P. polygama (Vent.) Engelm. & Gray. Jointweed.—Sandy stream banks, 14, rare.

Polygonum aviculare L. (incl. *P. neglectum* Besser). Knotweed.—Waste ground, 10, 13, rare.

**P. convolvulus* L. (*Bilderdykia convolvulus* (L.) Dum.). Black bindweed.—Railroad yards at Donalsonville, 18, rare.

**P. cristatum* Engelm. & Gray (*Bilderdykia cristata* (E. & G.) Greene, *B. dumetorum* (L.) Dum.). False-buckwheat.—Banks of the Chattahoochee River near Saffold, 12, rare.

P. hirsutum Walt. (*Persicaria hirsuta* (Walt.) Small).—Shallow water and wet margins of ponds and swamps, 9, 12, 14, rare.

P. hydropiperoides Michx. (*Persicaria hydropiperoides* (Michx.) Small, *Persicaria opelousana* (Ridd.) Small). Mild water-pepper.—Shallow water and wet margins of ponds, and marshy or swampy places generally, very common.

P. lapathifolium L. (*Persicaria lapathifolia* (L.) S. F. Gray). Pale smartweed.—Sandbar along Sawhatchee Creek near its junction with the Chattahoochee River, 12, rare.

P. pennsylvanicum L. (*Persicaria pennsylvanica* (L.) Small). Common smartweed.—Waste places, ditches, roadsides, and river banks, 1, 4, 10, 12, 13, 18, infrequent.

**P. persicaria* L. (*Persicaria persicaria* (L.) Small). Lady's thumb.—Railroad yards at Leary, 10, rare.

P. punctatum Ell. (*Persicaria punctata* (Ell.) Small). Water smartweed.—Moist places, frequent.

P. setaceum Baldwin (*Persicaria setacea* (Baldwin) Small).—Swamps and other wet places, 1, 9, 17, infrequent. Perhaps not specifically distinct from *P. hydropiperoides* Michx.

P. virginianum L. (*Tovara virginiana* (L.) Raf.). Jump-seed.—Moist, rich woods, mostly along the Chattahoochee River, 11, 12, 17, 18, infrequent.

Rumex altissimus Wood? Pale dock.—An immature specimen probably of this species was collected from a roadside ditch near Providence Canyons, west of Lumpkin, 3.

**R. crispus* L. Curly dock.—Waste places, ditches, and roadsides, frequent.

R. hastatulus Baldw. Sorrel.—Sandy fields, pecan groves, and roadsides, abundant.

R. verticillatus L. (incl. *R. floridanus* Meisn.). Swamp dock.—Swamps along streams, 9, 10, 14, rare.

CHENOPODIACEAE—Goosefoot Family

Chenopodium album L. (incl. *C. lanceolatum* Muhl.). Goosefoot.—Waste places, roadsides, and fields, frequent.

**C. ambrosioides* L. (*C. anthelminticum* L., *Ambrina ambrosioides* (L.) Spach). Wormseed.—Waste places, fields, and roadsides, common.

**C. carinatum* R. Br.—Roadsides and waste places, 14, 17, rare.

**C. giganteum* Don. (*C. amaranticolor* Coste & Reyn.).—Waste places and roadsides, 5, 7, 10, 14, infrequent.

AMARANTHACEAE—Amaranth Family

**Alternanthera repens* (L.) Kuntze (*Achyranthes repens* L.). Chaff flower.—Reported from a farmyard 5 miles north of Whigham, 16 (Harper 1906).

**Amaranthus hybridus* L. Pigweed.—Waste places and cultivated grounds, 9, 14, rare.

**A. retroflexus* L.—Waste places, 1, 18, rare.

**A. spinosus* L. Thorny amaranth.—Waste places, farmyards, fields, and roadsides, frequent.

**A. viridis* L. (*A. gracilis* Desf.).—Waste places, 9, 10, 12, 13, 17, 18, infrequent.

Froelichia floridana (Nutt.) Moq. Cottonweed.—Dry, sandy fields, oak barrens, and pinelands, common.

Iresine rhizomatosa Standl.—Wooded bottoms along the Chattahoochee River, 12, rare.

NYCTAGINACEAE—Four-o'clock Family

**Boerhaavia erecta* L. Spiderling.—Waste places, 1, 5, 9, 12, 18, infrequent.

(*Mirabilis jalapa* L. Four-o'clock.—Vacant lot in Albany, 9, where it may have been spontaneous.)

PHYTOLACCACEAE—Pokeweed Family

Phytolacca americana L. Pokeweed.—Waste places and cultivated ground, common.

AIZOACEAE—Carpet-weed Family

**Mollugo verticillata* L. Carpetweed.—Waste places, roadsides, river banks, and cultivated ground, common.

PORTULACACEAE—Purslane Family

Claytonia virginica L. Spring beauty.—Rich woods along Spring Creek east of Blakely,

**Portulaca oleracea* L. Purslane, pussley.—Waste places, 1, 9, 10, 17, 18, infrequent.

CORRIGIOLACEAE—Whitlowwort Family

Paronychia baldwinii (Torr. & Gray) Fenzl. (*Anychiastrum baldwinii* (T. & G.) Small).—Dry sandy soil, 9, 12, 17, 18, infrequent.

P. herniarioides (Michx.) Nutt. (*Gastronychia herniarioides* (Michx.) Small).—Dry sand along the Flint River, 15, 17, rare.

P. riparia Chapm. (*Anychiastrum riparium* (Chapm.) Small).—Dry sand of oak barrens and stream banks along or near the Flint River, the type locality being the banks of the Flint River at Bainbridge, frequent.

Siphonychia americana (Nutt) T. & G. (incl. *S. pauciflora* Small).—Dry, usually sandy woods, 5, 11, 14, infrequent.

S. diffusa Chapm.—Dry, sandy oak-pine woods west of Mosquito Creek, 3 miles north of Chattahoochee, Florida, 17, rare.

S. interior (Small) Core (*Odontonychia interior* Small).—Along Flint River at West Bainbridge, 17 (Core 1939), rare.

S. rugelii Chapm. (*Gibbesia rugelii* (Chapm.) Small).—Dry, sandy oak barrens and sandy banks of streams, 14, 17, infrequent.

CARYOPHYLLACEAE—Pink Family

**Agrostemma githago* L. Corn cockle.—Roadsides and waste places, 9, 18, rare.

Arenaria lanuginosa (Michx.) Rohrb.—Limestone outcrops and rich or sandy woods, frequent.

A. patula Michx. (*Sabulina patula* (Michx.) Small).—Limestone outcrops near Greers Cave and the adjacent limestone quarry, 5, rare.

**Cerastium viscosum* L. Mouse-ear chickweed.—Waste places, roadsides, and sandy fields, frequent.

Sagina decumbens (Ell.) T. & G. Pearlwort.—Sandy fields and roadsides, frequent.

**Saponaria officinalis* L. Bouncing-bet.—Roadside near Coleman, 5, rare.

Silene antirrhina L. Sleepy catchfly. Roadsides, waste places, and sandy fields, common.

S. baldwynii Nutt. (*S. polypetala* Fern. & Schubert).—Rich, dry woods of ravines in bluff one mile north of Chattahoochee, Florida, 17, rare.

S. ovata Pursh.—Rich, loamy, wooded ravine slopes near Fort Gaines, 11, rare.

S. regia Sims.—Dry, open woods near the limestone quarry 8 miles north of Cuthbert, 5, rare.

**Stellaria media* (L.) Cyrillo (*Alsine media* L.). Chickweed.—Cultivated grounds, waste places, and roadsides, common.

S. pubera Michx. (*Alsine pubera* (Michx.) Britt.) Great Chickweed.—Rich, loamy wooded bluff along the Chattahoochee River near Hilton, 12, rare.

Stipulicida setacea Michx. (incl. *S. filiformis* Nash).—Dry sandy woods, 5, 14, 17, infrequent.

NYMPHAEACEAE—Water-lily Family

- Brasenia schreberi* Gmel. Water shield, purple bonnet.—Ponds, common.
Cabomba pulcherrima (Harper) Fassett. Fanwort.—Ponds in the southern counties, 13, 17, 18, infrequent.
Nelumbo lutea (Willd.) Pers. (?*N. pentapetala* (Walt.) Fern.) Lotus, water-chinquapin.—Ponds, frequent.
Nuphar advena (Ait.) Ait. f. (*Nymphaea advena* Ait., *N. fluvialis* Harper) Bonnet, spatter-dock, cow-lily.—Ponds, sloughs, and sluggish streams, 7, 12, 13, 14, 17, 18, infrequent.
N. orbiculatum (Small) Standl. (*Nymphaea orbiculata* Small, *N. bombycina* Miller & Standley).—Ponds in the southern counties, 12, 17, 18, infrequent.
Nymphaea odorata Ait. (*Castalia odorata* (Ait.) Woodv. & Wood, *C. lekophylla* Small, *C. minor* (Sims) DC.). Water-lily.—Ponds and ditches, common.

CERATOPHYLLACEAE—Hornwort Family

- Ceratophyllum demersum* L. Hornwort.—Shallow water of spring-heads and streams, 9, rare.
C. echinatum A. Gray.—Shallow water of cypress ponds, 14, rare.

RANUNCULACEAE—Buttercup Family

- Actaea alba* (L.) Mill. (*A. pachypoda* Ell.). White baneberry.—Rich shady woods northwest of Cuthbert, 5, rare.
Anemone caroliniana Walt. Anemone.—Grassy roadside 2 miles west of Pretoria, 9, rare.
A. virginiana L. Thimble weed.—Open or shady, usually calcareous woods, 5, 7, rare.
Anemonella thalictroides (L.) Spach (*Syndesmon thalictroides* (L.) Hoffmgg.). Rue-anemone.—Rich, moist, wooded ravine slopes in the Red Hills, 11, rare.
Aquilegia canadensis L. Columbine.—Rich, calcareous woods near Greers Cave, 5, rare.
Clematis catesbyana Pursh. Satin-curles.—Bottom woods along the lower part of the Chattahoochee River, 12, 18, rare.
C. crispa L. (*Viorna crispa* (L.) Small, *V. obliqua* Small). Blue-jasmine.—Swamps, moist pinelands, and stream margins on the Dougherty Plain, common.
**C. discoreifolia* Levl. & Vaniot (*C. paniculata* Thunb., not Gmel.).—Marshy area with scattered alders near Americus, 1, rare.
C. reticulata Walt. (*Viorna reticulata* (Walt.) Small).—Sandy woods and thickets mostly in the Red Hills and along the escarpment, frequent.
C. viorna L. (*Viorna viorna* (L.) Small, *V. glaucophylla* Small). Leather flower, vase vine.—River banks and bluffs, frequent.
C. virginiana L. Virgin's bower.—Along Pumpkin Creek northeast of Springvale, 5, rare.
**Delphinium ajacis* L. Larkspur.—Waste places and roadsides, infrequent.
D. carolinianum Walt.—Dry, open woods, 5, 9, rare.
Hepatica americana (DC.) Ker. (*Hepatica hepatica* (L.) Karst.).—Wooded slopes and steep banks of ravines in the Red Hills, 5, 12, rare.
Ranunculus abortivus L. Small-flowered buttercup.—Along the Chattahoochee River in bottom woods and waste places, 11, 12, 18, infrequent.
R. carolinianus DC. (*R. palmatus* of authors, not Ell.).—Swamps and moist woods, 7, 12, infrequent.
R. laxicaulis (T. & G.) Darby (*R. oblongifolius* of authors, not Ell.).—Wet pond margins, 9, 14, 15, infrequent.
**R. parviflorus* L.—Waste ground, 11, rare.
R. pusillus Poir. (incl. *R. lindheimeri* Engelm.). Spearwort.—Moist bottomlands, shallow water of pond margins and ditches, and marshy places generally, mostly along the Chattahoochee River, 11, 12, 14, 18, infrequent.
R. recurvatus Poir. Blisterwort, hooked buttercup.—Rich, moist, open woods, 5, 12, rare.
Thalictrum macrostylum (Shuttlw.) Small & Heller (*T. subrotundum* Boivin). Meadow rue.—Moist ground, 7, 8, rare.
T. revolutum DC.—Rich, moist or rocky woods, 5, 7, 9, 12, 14, infrequent.

Trautvetteria carolinensis (Walt.) Vail. False-bugbane.—Sandy swamp near Hilton, 12, rare.

Xanthorhiza simplicissima Marsh. Yellow root.—Moist, wooded banks, ravine slopes, and bluffs in the Red Hills, 4, 5, 11, infrequent.

BERBERIDACEAE—Barberry Family

Podophyllum peltatum L. May-apple.—Rich, moist or rocky woods in the Red Hills, 5, 11, 12, infrequent.

MENISPERMACEAE—Moonseed Family

Calycocarpum lyoni (Pursh) A. Gray. Cupseed.—Wooded bottoms and banks of the Chattahoochee and Flint rivers, frequent.

Cocculus carolinus (L.) DC. (*Epibaterium carolinum* (L.) Britt.). Coralbeads, snailseed.—Common in moist or dry woods, usually along streams; frequent in thickets or other weedy places.

Menispermum canadense L. Moonseed.—Alluvial, wooded bottoms along streams, 12, 13, 14, rare.

MAGNOLIACEAE—Magnolia Family

Liriodendron tulipifera L. Tulip tree, yellow-poplar.—Rich, moist or wet woods in ravines and in swamps in the Red Hills, along the escarpment, and on the inner part of the Dougherty Plain, very common.

Magnolia acuminata L. (*Tulipastrum acuminatum* (L.) Small). Cucumber tree.—Rich, wooded ravine about 2 miles northwest of Lumpkin, 3, rare.

M. fraseri Walt. (incl. *M. pyramidata* Bartr.). Umbrella tree, oread.—Rich woods on ravine slopes, 5, 11, 12, 17, frequent.

M. grandiflora L. Magnolia, laurel.—Hammocks and rich woods of bottoms, stream banks, ravines, and bluffs, abundant; one of the dominant members of the climax vegetation in both the Red Hills and the Dougherty Plain.

M. macrophylla Michx. Big-leaf magnolia.—Rich woods on ravine slopes in the Red Hills, 3, 5, 11, infrequent.

M. tripetala L. Umbrella tree.—Rich woods of ravines in the Red Hills, 5, rare.

M. virginiana L. Sweet-bay, white-bay.—Swamps, moist hammocks, bogs, moist pinelands (usually as a shrub), seepage slopes, and moist or wet woods of ravine bottoms and slopes, abundant.

CALYCANTHACEAE—Strawberry-shrub Family

Calycanthus floridus L. Sweet shrub, Carolina-all-spice.—Rich woods of ravines, frequent.

ANNONACEAE—Custard-apple Family

Asimina angustifolia A. Gray (*Pityothamnus angustifolius* (A. Gray) Small).—Dry, sandy pinelands, oak barrens, and hammocks on the Dougherty Plain, common.

A. parviflora (Michx.) Dunal. Dwarf pawpaw.—Hammocks and rich woods, common.

LAURACEAE—Laurel Family

Lindera benzoin (L.) Blume (*Benzoin aestivalis* (L.) Nees). Spice bush.—Moist woods along streams, frequent.

Litsea aestivalis (L.) Fern. (*Glabraria geniculata* (Walt.) Britt.). Pond spice.—One shrub was found on the swampy border of Aycocks Creek 4 miles west of Colquitt, 13, rare.

Persea borbonia (L.) Spreng. (*Tamala borbonia* (L.) Raf.). Red-bay.—Dry, sandy hammocks, dry woods, and river banks, frequent.

P. palustris (Raf.) Sarg. (*Tamala pubescens* (Pursh) Small). Swamp-bay.—Sandy swamps, wet hammocks, bogs, wet woods in ravine bottoms, and seepage slopes, usually with *Magnolia virginiana*, very common.

Sassafras albidum (Nutt.) Nees (*S. sassafras* (L.) Karst.). Sassafras.—Old fields, fence-rows, roadsides, and dry woods, abundant.

PAPAVERACEAE—Poppy Family

**Argemone alba* Lestib. f. Prickly poppy.—Roadsides, fields, and waste places, 5, 11, 14, 15, 17, infrequent.

**Eschscholtzia californica* Cham. California poppy.—Escaped along roadsides and in waste places, 1, 2, 10, 12, infrequent.

Sanguinaria canadensis L. (incl. var. *rotundifolia* (Greene) Fedde). Bloodroot.—Rich woods, frequent.

FUMARIACEAE—Fumitory Family

Corydalis flavula (Raf.) DC. (*Capnoides flavulum* (Raf.) Kuntze). Yellow fumeroot.—Moist, wooded bottoms along the Chattahoochee River near Neal's Landing bridge, 18, rare.

C. micrantha (Engelm.) A. Gray ssp. *australis* (Chapm.) Ownbey (*Capnoides halci* Small).—Fields, open woods, roadsides, and waste places along or near the Chattahoochee River, 11, 12, 17, infrequent.

**Fumaria officinalis* L. Fumitory.—Along a roadside and in a vacant lot in Donaldsonville, 18, rare.

CAPPARIDACEAE—Caper Family

**Cleome spinosa* Jacq. (*Neocleome spinosa* (Jacq.) Small). Spider flower.—Roadside ditch several miles west of Edison, 10, rare.

CRUCIFERAE—Mustard Family

**Arabidopsis thaliana* (L.) Heynh. Mouse-ear cress.—Fields and roadsides in the northern part of the area, 2, 5, rare.

Arabis canadensis L. Sicklepod.—Open woods on limestone outcrops near Greers Cave, 5, rare.

A. georgiana Harper.—Bluffs along the Chattahoochee River, with the type station below Omaha, 3, 11, rare.

Armoracia aquatica (Eat.) Wieg. (*Neobackia aquatica* (Eat.) Britt.). Lake cress.—Shallow water of swamp along Kiokee Creek west of Pretoria, 9, rare.

**Brassica juncea* (L.) Cosson (incl. var. *crispifolia* Bailey, *B. japonica* of the *Manual*, not Siebold). Indian mustard, curled mustard.—Railroad yards and waste places, 9, 18, rare.

**B. kaber* (DC.) L. C. Wheeler (*Sinapis arvensis* L.). Charlock.—Roadsides, fields, and waste places, 1, 9, 11, 15, 18, infrequent.

**B. napus* L. (*B. campestris* of the *Manual* in part). Turnip.—Waste ground, 9, rare; doubtfully persistent.

**B. rapa* L. (*B. campestris* of the *Manual* in part). Field mustard.—Roadsides and waste places, 9, 18, rare.

**Capsella bursa-pastoris* (L.) Medic. (*Bursa bursa-pastoris* (L.) Britt.). Shepherd's purse.—Waste places and roadsides, frequent.

Cardamine bulbosa (Schreb.) B. S. P. Bitter cress.—Swampy or moist woods, 7, 9, 10, 12, infrequent.

C. parviflora L. (incl. *C. arenicola* Britt.).—Fields, roadsides, and banks and bluffs along the Chattahoochee River, 7, 9, 11, 18, infrequent.

C. pensylvanica Muhl.—Moist, rich woods, 12, rare.

**Coronopus didymus* (L.) Sm. (*Carara didyma* (L.) Britt.).—Waste places, roadsides, and fields, frequent.

Dentaria laciniata Muhl.—Moist, rich woods 1 mile north of Chattahoochee, Florida, 17, rare.

Draba brachycarpa Nutt. Whitlow-grass. Dry, open places, 9, 11, rare.

Lepidium virginicum L. Pepper-grass.—Roadsides, waste places, and fields, common.

**Nasturtium officinale* R. Br. (*Sisymbrium nasturtium-aquaticum* L.). Water-cress.—Small branch near railroad terminal at Fort Gaines, 11, rare.

**Raphanus raphanistrum* L. Wild radish. Grain fields and roadsides, frequent.

**Raphanus sativus* L. Radish.—Grain fields and roadsides, 1, 9, 14, infrequent.

Rorippa islandica (Oeder) Borbás (*Radicula palustris* (L.) Moench.). Marsh cress.—Streams and margins of swamps, 10, 12, 18, rare.

R. sessiliflora (Nutt.) A. Hitchc. (*Radicula sessiliflora* (Nutt.) Greene).—Muddy margins of ponds and streams, 12, 17, rare.

Sisara virginica (L.) Rollins (*Arabis virginica* (L.) Poir.).—Sandy fields, waste places, and roadsides, infrequent.

**Thlaspi arvense* L. Penny cress, Frenchweed.—Waste places and fields, 11, 17, rare.

SARRACENIACEAE—Pitcher-plant Family

Sarracenia flava L. Trumpets.—Moist pinelands, 8, 10, rare.

S. leucophylla Raf. (*S. drummondii* Croom). Purple trumpet.—Sandy bogs around Americus, 1, rare.

S. minor Walt. Hooded pitcher plant.—Moist pinelands, 1, 7, 8, 10, 12, 14, 15, frequent.

S. purpurea L. ssp. *venosa* (Raf.) Wherry. Pitcher plant.—Small bog along railroad 1 mile west of Coleman, 5, rare.

S. rubra Walt. Sweet pitcher plant.—Sandy bogs, 1, 12, rare.

DROSERACEAE—Sundew Family

Drosera brevifolia Pursh.—Wet sand of moist pinelands and bogs, 5, 7, 12, 13, 17, infrequent.

D. capillaris Poir.—Wet sand of moist pinelands and bogs, 1, 5, 9, 10, 12, 14, 15, 17, frequent.

D. intermedia Hayne.—One specimen, not completely typical, seen from open, wet pinelands north of Leesburg, 7, rare.

PODOSTEMACEAE—Riverweed Family

Podostemum ceratophyllum Michx. (incl. *P. abrotanoides* Nutt.). Riverweed.—Rocky shoals in the Flint River, 9, 14, 15, rare.

SAXIFRAGACEAE—Saxifrage Family

Decumaria barbara L. Wood-vamp, climbing-hydrangea.—In rich, moist or swampy woods climbing on trees and occasionally on rocks, usually near streams, very common.

Heuchera americana L. Alumroot.—Bluff above the Chattahoochee River near Fort Gaines, 11, rare.

Hydrangea arborescens L. Smooth hydrangea.—Rich woods of ravines and bluffs in the Red Hills, 5, 11, 12, 17, infrequent.

H. quercifolia Bartr. Seven-bark, oak-leaf hydrangea.—Rich woods of ravines, bluffs, and river banks, mostly in the Red Hills and along the escarpment; common; not seen in the watershed of the Flint River north of the Faceville area.

Itea virginica L. Virginia-willow.—Swamps, wet woods, and pond and stream margins, abundant.

Penthorum sedoides L. Ditch-stonecrop.—Moist or swampy woods, frequent.

Philadelphus inodorus L. (incl. *P. grandiflorus* Willd.). Mock-orange.—Infrequent on banks and bluffs along the Chattahoochee River; rare elsewhere, 7, 11, 12.

Tiarella cordifolia L. ssp. *austrina* (Lakela) Wherry (incl. *T. wherryi* Lakela). False-mitrewort, foam flower.—Rich woods of ravines in the Red Hills, 11, 12, infrequent.

HAMAMELIDACEAE—Witch-hazel Family

Hamamelis virginiana L. (incl. *H. macrophylla* Pursh). Witch-hazel.—Sandy hammocks and rich woods, common.

Liquidambar styraciflua L. Sweet gum.—Abundant in many habitats.

PLATANACEAE—Planetree Family

Platanus occidentalis L. Sycamore.—Common along the larger streams; infrequent in rich woods of ravines.

ROSACEAE—Rose Family

Agrimonia incisa Torr. & Gray. Agrimony.—Dry pine or oak woods, 12, 13, 17, infrequent.

A. microcarpa Wallr.—Woods and thickets, frequent.

A. rostellata Wallr.—Rich woods along streams, 7, 12, rare.

**Alchemilla microcarpa* Boiss. & Reut. (*Aphanes australis* Rydb.). Parsley piert.—Lawn in Albany, 9, rare.

Amelanchier arborea (Michx. f.) Fern. (*A. canadensis* of the Manual). Shadbush, juneberry.—Hammocks, ravines, bluffs, and stream banks, common, but scattered.

A. canadensis (L.) Medic. (*A. oblongifolia* T. & G.).—Low woods along Pachitla Creek west of Morgan, 10, rare.

Chrysobalanus oblongifolius Michx. (*Geobalanus oblongifolius* (Michx.) Small). Gopher-apple.—Dry, sandy pinelands and oak barrens on the Dougherty Plain, frequent.

Crataegus aestivalis (Walt.) T. & G. Mayhaw.—Shallow ponds and sloughs on the Dougherty Plain, abundant.

C. biltmoreana Beadle (*C. intricata* of the *Manual*).—Woods, 11, 17, rare.

C. brachyacantha Engelm. & Sarg.—Open pinelands several miles northeast of Newton, 14, rare.

C. calpodendron (Ehrh.) Medic. (*C. tomentosa* Du Roi, not L.). Pear haw.—Dry, open woods near limestone quarry 8 miles north of Cuthbert, 5, rare.

C. crus-galli L. Cockspur thorn.—Moist woods along streams, 9, 13, 14, infrequent.

C. marshallii Eggleston. Parsley haw.—Bottomlands, moist woods, and stream banks, common.

C. michauxii Pers. (incl. *C. floridana* Sarg.).—Dry, usually sandy, open woods and old fields, common.

C. spathulata Michx.—Open woods of bottomlands, stream banks, and ravines, mostly along the Flint and Chattahoochee rivers, common.

C. uniflora Muenchh. Dwarf thorn.—Dry woods, common.

C. viridis L. (*C. arborescens* Ell.).—Rich woods of bottomlands, stream banks, bluffs, and ravines, common.

**Duchesnea indica* (Andr.) Focke. Indian-strawberry.—Waste places and roadsides, 7, 11, 12, 18, infrequent.

Fragaria virginiana Duchesne. Wild strawberry.—Dry, open woods, 5, 6, 9, 10, 11, infrequent.

Physocarpus opulifolius (L.) Maxim. (*Opulaster alabamensis* Rydb., *O. opulifolius* (L.) Kuntze, *O. stellatus* Rydb.). Ninebark.—Sandy swamp 2 miles south of Hilton, 12, rare.

Potentilla simplex Michx.—Railroad embankment just north of Fort Gaines, 11, where probably introduced, rare.

Prunus americana Marsh. Wild plum.—Rich, often dry or rocky woods, especially along the Chattahoochee River and in calcareous areas, 5, 7, 11, 12, 17, 18, infrequent.

P. angustifolia Marsh. Chickasaw plum.—Old fields, fence-rows, and open borders of woods, appearing to be introduced, very common.

P. caroliniana (Mill.) Ait. (*Laurocerasus caroliniana* (Mill.) Roem.). Mock-orange.—Frequent in hammocks and on stream banks; more common as an escape in fence-rows and in dry, open woods.

**P. persica* (L.) Batsch. (*Amygdalus persica* L.). Peach.—Escaped in fields and along roadsides, infrequent.

P. serotina Ehrh. (*Padus virginiana* of the *Manual*). Wild black cherry.—Woods, old fields, roadsides, and fence-rows, common.

P. umbellata Ell. (incl. *P. injucunda* Small, *P. mitis* Beadle). Hog plum, sloe.—Sandy hammocks and dry woods, common.

Pyrus angustifolia Ait. (*Malus angustifolia* (Ait.) Michx., *M. bracteata* Rehder). Crab apple.—Sandy, open woods, common.

P. arbutifolia (L.) L. f. (*Aronia arbutifolia* (L.) Ell.). Red chokeberry.—Moist pinelands, bogs, cypress ponds, and sandy swamps, common.

**P. communis* L. Pear.—Escaped in dry, sandy woods, 14, 17, rare.

Rosa carolina L. Pasture rose.—Dry, sandy woods, fields, and roadsides, frequent.

**R. laevigata* Michx. Cherokee rose.—Thickets along streams and on roadsides, infrequent.

R. palustris Marsh. (incl. *R. floridana* Rydb.). Swamp rose.—Cypress ponds, wet pinelands, and swamps, common.

Rubus argutus Link. (incl. *R. floridus* of the *Manual*, *R. betulifolius* Small).—Moist, often sandy woods, swamps, bogs, wet pinelands, and ravine bottoms, very common.

R. cuneifolius Pursh (incl. *R. probabilis* Bailey). Sand blackberry.—Sandy fields, open woods, and roadsides, abundant.

R. enslenii Tratt. (incl. *R. bonus* Bailey). Dewberry.—Dry, open woods, 3, 5, 12, 17, infrequent.

R. flagellaris Willd.—Dry, open woods and roadsides, 5, 9, 10, 12, 15, infrequent.

R. trivialis Michx. Dewberry.—Open woods, fields, and roadsides, abundant.

LEGUMINOSAE—Legume Family

- **Albizia julibrissin* Durazz. Mimosa.—Woods and roadsides, frequent.
- Amorpha fruticosa* L. (incl. *A. virgata* Small, *A. croceolata* P. W. Wats., *A. curtisii* Rydb.). Indigobush.—Along streams, abundant.
- A. herbacea* Walt.—Reported from 7 (Harper 1906), rare.
- Amphicarpa bracteata* (L.) Fern. (incl. var. *comosa* (L.) Fern., *Falcata comosa* (L.) Kuntze). Hog-peanut.—Rich, moist woods, especially in ravines, 1, 5, 7, 11, 17, infrequent.
- Apios americana* Medic. (*Glycine apios* L., *A. tuberosa* Moench.). Groundnut.—Moist thickets and woods and margins of streams and ponds, mostly in the northern half of the area, frequent.
- **Arachis hypogaea* L. Peanut.—Frequent escape in waste places, along roadsides, and in open woods; doubtfully naturalized.
- Astragalus intonsus* Sheldon (*Phaca intonsa* (Sheldon) Rydb.). Milk-vetch.—Dry, sandy soil of pinelands, oak barrens, and old fields, frequent.
- A. michauxii* Kuntze (*Tium michauxii* (Kuntze) Rydb.).—Very dry pine barrens, 1 (Harper 1906), rare.
- Baptisia alba* (L.) Vent. False-indigo.—Dry woods, mostly in the northern two-thirds of the area, common.
- B. lanceolata* (Walt.) Ell. (incl. *B. elliptica* Small).—Dry pinelands and oak woods in the eastern and northern parts of the area, frequent.
- B. leucantha* Torr. & Gray (incl. *B. pendula* Larisey, *B. psammophila* Larisey).—Sandy banks, alluvial bottomlands, and dry woods of the Flint River and tributary streams, common.
- Cassia fasciculata* Michx. (*Chamaecrista fasciculata* (Michx.) Greene, *Chamaecrista littoralis* Pollard, *C. robusta* Pollard, *C. depressa* (Pollard) Greene). Partridge-pea.—Sandy fields, pinelands, and dry, open woods, common.
- C. marilandica* L. (*Ditremexa medsgeri* (Shafer) Britt. & Rose, not *D. marylandica* of the *Manual*). Wild senna.—Alluvial soil along the Flint River, 14, 15, rare.
- C. nictitans* L. (*Chamaecrista procumbens* (L.) Greene, *Chamaecrista mohrrii* (Pollard) Small). Sensitive plant.—Dry, sandy fields, open woods, roadsides, and slopes on the Dougherty Plain, frequent.
- **C. occidentalis* L. (*Ditremexa occidentalis* (L.) Britt. & Rose). Coffee-weed.—Waste places, roadsides, barn-yards, and cultivated fields, common.
- **C. tora* L. (*Emelista tora* (L.) Britt. & Rose). Coffee-weed, sickle pod.—Cultivated fields, barn-yards, waste places, and roadsides, common.
- Centrosema virginianum* (L.) Benth. (*Bradburya virginiana* (L.) Kuntze). Butterfly pea.—Sandy fields, pinelands, dry, open woods, and roadsides, common.
- Cercis canadensis* L. Redbud.—Hammocks and rich woods, mostly along streams, very common.
- Clitoria mariana* L. (*Martiusia mariana* (L.) Small). Butterfly pea.—Dry, sandy pinelands and oak woods, frequent.
- **Crotalaria mucronata* Desv. (*C. striata* DC.). Rattlebox.—Roadsides, 12, 15, 17, infrequent.
- C. ovalis* Pursh (*C. rotundifolia* of the *Manual*, *C. angulata* of Senn, prob. not Miller).—Sandy pinelands and dry woods, common.
- C. purshii* DC.—Sandy pinelands on the Dougherty Plain, frequent.
- **C. retusa* L.—Roadsides and waste places, 9, 14, 17, rare.
- **C. spectabilis* Roth (*C. retzii* A. Hitchc.).—Roadsides and fields, frequent.
- Desmodium canescens* (L.) DC. (*Meiboma canescens* (L.) Kuntze). Tick trefoil.—Dry, open woods and thickets, frequent.
- D. ciliare* (Muhl.) DC. (*Meiboma ciliaris* (Muhl.) Blake).—Dry, sandy pinelands and open woods, frequent.
- D. cuspidatum* (Muhl.) Lour. (*Meiboma grandiflora* (Walt.) Kuntze, *M. longifolia* (T. & G.) Vail, *M. bracteosa* (L.) Kuntze).—Rich or rocky woods, 7, 12, 14, infrequent.
- D. glutinosum* (Muhl.) Wood (*Meiboma acuminata* (Michx.) Blake).—Rich woods, 1, 5, 11, 12, 17, infrequent.
- D. laevigatum* (Nutt.) DC. (*Meiboma laevigata* (Nutt.) Kuntze).—Dry, open woods, frequent.

- D. lineatum* DC. (*Meiboma arenicola* Vail).—Sandy pinelands and dry, open woods, common.
- D. marilandicum* (L.) DC. (*Meiboma marilandica* (L.) Kuntze).—Dry, open woods, 5, 6, 7, 14, 17, 18, infrequent.
- D. nudiflorum* (L.) DC. (*Meiboma nudiflora* (L.) Kuntze).—Rich, rocky, or dry woods, frequent.
- D. ochroleucum* M. A. Curtis (*Meiboma ochroleuca* (M. A. Curtis) Kuntze).—Dry, open margin of rich, calcareous woods by Indian Den along Fowltown Creek, 7, rare.
- D. paniculatum* (L.) DC. (*Meiboma paniculata* (L.) Kuntze, *M. pubens* (T. & G.) Young, *M. chapmanii* (Britt.) Small).—Dry, open woods, usually near streams, common.
- D. pauciflorum* (Nutt.) DC. (*Meiboma pauciflora* (Nutt.) Kuntze).—Rich woods, 1, 11, 18, rare.
- D. perplexum* Schub. (*Meiboma dillenii* of the *Manual*).—Dry, sandy open woods, 10, 12, 14, 17, infrequent.
- D. rigidum* (Ell.) DC. (*Meiboma rigida* (Ell.) Kuntze).—Dry, open woods, 10, 17, rare.
- D. rotundifolium* (Michx.) DC. (*Meiboma michauxii* Vail). Dollar leaf.—Dry, rocky, or rich woods, 10, 11, 12, 17, infrequent.
- D. strictum* (Pursh) DC. (*Meiboma stricta* (Pursh) Kuntze).—Dry sandy pinelands and oak barrens, 1, 7, 17, rare.
- D. tenuifolium* Torr. & Gray (*Meiboma tenuifolia* (T. & G.) Kuntze).—Moist pinelands, 7, 10, 12, 13, 15, 17, infrequent.
- **D. tortuosum* (Sw.) DC. (*Meiboma purpurea* (Mill.) Vail). Florida beggarweed.—Roadsides, old fields, and waste places, common.
- D. viridiflorum* (L.) DC. (*Meiboma viridiflora* (L.) Kuntze, *M. rhombifolia* (Ell.) Vail).—Dry pinelands and dry, open woods, common.
- Erythrina herbacea* L. Cherokee bean, cardinal spear.—Dry pinelands and dry, open woods, common.
- Galactia erecta* (Walt.) Vail. Milk pea.—Dry, sandy pinelands, 1, 8, 10, 11, 13, 14, infrequent.
- G. floridana* Torr. & Gray.—Dry, sandy oak barrens between Open and Cane Water ponds, 17, rare.
- G. mollis* Michx.—Dry pinelands and oak barrens, frequent.
- G. regularis* (L.) B. S. P.—Dry, sandy oak-pine woods and oak barrens, 5, 9, 14, infrequent.
- G. volubilis* (L.) Britt.—Banks of the Chattahoochee River and other streams and dry woods, frequent.
- Gleditsia aquatica* Marsh. Water locust.—Swamps and margins of streams on the Dougherty Plain, common; not seen west of Spring Creek except near the confluence of the Flint and Chattahoochee rivers.
- G. triacanthos* L. Honey Locust.—Bottomlands and roadsides, frequent.
- Indigofera caroliniana* Mill. Indigo.—Dry pinelands, oak-pine woods, and oak barrens, frequent.
- Kuhnistera pinnata* (Walt.) Kuntze. Summer farewell.—Dry pinelands and oak barrens, common.
- **Lathyrus* sp.—Roadsides and railroads, 9, 18, rare; apparently an introduced species not previously reported as an escape in the Southeast, not seen in bloom.
- Lepedeza angustifolia* (Pursh) Ell. Bush-clover.—Dry pinelands and open woods, 10, 12, 14, 18, infrequent.
- L. capitata* Michx.—Dry, sandy pinelands and oak woods, frequent.
- **L. cuneata* (Dumont) G. Don. (*L. sericea* Miq., not Benth.).—Roadsides and fields, 12, 14, 18, rare; a recently introduced legume.
- L. hirta* (L.) Hornem.—Dry, open woods, 5, 8, 10, 11, 12, 15, infrequent.
- L. intermedia* (Wats.) Britt. (*L. frutescens* (L.) Britt.).—Dry open woods, 5, 9, 11, 12, infrequent.
- L. nuttallii* Darl.—Dry, open sandy oak barrens, 14, 17, rare.
- L. procumbens* Michx.—Dry pinelands and open, sandy woods, 10, 12, 17, rare.
- L. repens* (L.) Bart.—Dry pinelands, open oak-pine woods, oak barrens, and sandy old fields, frequent.
- **L. striata* (Thunb.) H. & A. Japanese-clover.—Roadsides, fields, and open woods, common.

L. stuevei Nutt. (incl. *L. neglecta* (Britt.) Mack. & Bush).—Dry, sandy soil of old fields and open woods, frequent.

L. virginica (L.) Britt.—Dry, sandy open woods, oak barrens, and fields, common.

(**Lupinus angustifolius* Ait. Blue lupine.—Infrequent escape on roadsides, but probably not established; a winter annual extensively planted in southwestern Georgia for green manure.)

L. nuttallii S. Wats.—Dry, sandy oak woods, 5, 6, rare.

L. villosus Willd. Hairy lupine.—Dry pinelands and sandy oak barrens, frequent.

**Medicago arabica* (L.) Huds. Spotted medick.—Roadsides and waste places, 1, 9, 10, 11, 12, infrequent.

**M. lupulina* L. Black medick.—Waste places and roadsides, frequent.

(**M. sativa* L. Alfalfa.—Railroad yards in Albany, 9, rare; apparently not naturalized in southwestern Georgia.)

**Melilotus albus* Desr. White sweet-clover.—Waste places and roadsides, 9, 12, 17, 18, infrequent.

**M. indicus* (L.) All. Indian-clover.—Waste places and roadsides, 9, 10, 15, infrequent.

(**Parkinsonia aculeata* L. Jerusalem-thorn.—An escape in waste grounds in Albany; apparently not naturalized in southwestern Georgia.)

Petalostemum albidus (Torr. & Gray) Small.—Dry, sandy pinelands and oak barrens, frequent.

Phaseolus polystachios (L.) B.S.P. Wild bean.—Rich, dry or rocky woods, frequent.

P. sinuatus Nutt. Wild bean.—Dry oak-pine woods, 1, 13, rare.

Psoralea canescens Michx. (*Pediomelum canescens* (Michx.) Rydb.).—Dry, sandy pinelands and oak barrens, frequent.

P. lupinellus Michx. (*Rhytidomene lupinellus* (Michx.) Rydb.).—Dry pinelands and oak barrens, 1, 7, 14, infrequent.

P. psoralioides (Walt.) Carey (*Orbexilum pedunculatum* (Mill.) Rydb., *O. gracile* (Chapm.) Rydb.).—Dry, sandy pinelands and open oak woods, 1, 7, 9, 10, 14, infrequent.

**Pueraria lobata* (Willd.) Ohwi (*P. thunbergiana* (Sieb. & Zucc.) Benth.). Kudzu vine.—Roadsides, banks, and fields, frequent.

Rhynchosia difformis (Ell.) DC. (*R. tomentosa* of the *Manual*).—Dry, sandy pinelands and oak woods, frequent.

R. simplicifolia (Walt.) Wood.—Dry, sandy pinelands, open woods, and fields, common.

R. tomentosa (L.) H. & A. (*R. erecta* (Walt.) DC., *R. intermedia* (T. & G.) Small).—Dry, sandy pinelands and open oak woods, frequent.

Robinia pseudo-acacia L. Black locust.—Ravines and roadsides, 3, 9, 11, 17, infrequent.

Schrankia microphylla (Dryand.) Macbr. (*Leptoglottis microphylla* (Dryand.) Britt.).—Dry pinelands, oak woods, and sandy barrens, common.

Sesbania exaltata (Raf.) Cory (*Sesban emerus* (Aubl.) Britt. & Wilson, *Sesbania macrocarpa* Muhl., *Sesban exaltata* (Raf.) Rydb.).—Moist places, 9, 13, 17, 18, infrequent.

**S. punicea* (Cav.) Benth. (*Daubentonia punicea* (Cav.) DC.).—Escaped in waste places and on roadsides, 9, 17, infrequent.

S. vesicaria (Jacq.) DC. (*Glottidium vesicarium* (Jacq.) Mohr). Bladder pod.—Moist ground, roadsides, fields, frequent.

Strophostyles helvola (L.) Ell. Trailing wild bean.—Bank of the Chattahoochee River near Neal's Landing bridge, 18, rare.

S. umbellata (Muhl.) Britt.—Sandy pinelands, open woods, and old fields, frequent.

Stylosanthes biflora (L.) B.S.P. Pencil flower.—Dry, sandy pinelands, oak woods, and oak barrens, common.

Tephrosia ambigua (M. A. Curtis) Chapm. (*Cracca ambigua* (M. A. Curtis) Kuntze). Hoary pea.—Sandy pinelands, dry, open woods, oak barrens, and old fields, frequent.

T. spicata (Walt.) T. & G. (*Cracca spicata* (Walt.) Kuntze).—Pinelands, oak barrens, and dry, open oak woods, frequent.

T. virginiana (L.) Pers. (*Cracca virginiana* L.). Goat's-rue, devil's shoestring.—Dry, sandy pinelands, oak barrens, and open oak woods, common.

Trifolium carolinianum Walt. Clover.—Sandy fields, roadsides, and waste places, common.

**T. dubium* Sibth. Hop clover, shamrock.—Railroad terminal at Fort Gaines, 11, rare.

**T. pratense* L. Red clover.—Railroad yards in Albany, 9, rare; apparently not naturalized in southwestern Georgia.

**T. procumbens* L. Low hop clover.—Railroad yards, 9, 18, rare.

T. reflexum L. Buffalo clover.—Roadsides, open woods, and river banks, 9, 14, 17, infrequent.

**T. repens* L. White clover, Dutch clover.—Waste places and fields, 5, 9, 11, 12, infrequent.

**Vicia angustifolia* (L.) Reichard. Common vetch.—Roadsides and waste places, frequent.

**V. cracca* L.—Roadsides, 9, 10, 15, infrequent.

**V. hirsuta* (L.) S. F. Gray. Hairy Vetch, rare.—Vacant lot in Albany, 9, rare.

V. hugeri Small.—Rich woods on ravine slopes in the Red Hills, 5, 11, infrequent.

V. micrantha Nutt.—Bluffs, ravines, and waste places, 11, 17, rare.

**V. sativa* L.—Roadsides, 9, rare.

**V. tetrasperma* (L.) Moench. Lentil tare.—Railroad terminal at Fort Gaines, 11, rare.

Wisteria frutescens (L.) Poir. (*Kraunhia frutescens* (L.) Britt.). Wisteria.—Stream margins, swamps, and wet woods, common.

(**W. sinensis* Sweet. Chinese wisteria.—Occasionally persisting near old homesites; probably not spontaneous.)

Zornia bracteata (Walt.) Gmel.—Dry, sandy soil, usually near streams and mostly on the Dougherty Plain, frequent.

OXALIDACEAE—Wood Sorrel Family

Oxalis corniculata L. (*Xanthoxalis corniculata* (L.) Small, *X. langloisii* Small). Wood sorrel.—Margin of woods near Dry Creek, four miles east of Blakely, 12, rare.

**O. europaea* Jordan (incl. *Xanthoxalis cymosa* Small, *X. bushii* Small, *X. rufa* Small).—Dry woods of a ravine slope near Fort Gaines, 11, rare.

O. filipes Small (*Xanthoxalis filipes* (Small) Small).—Sandy soil, 7, 14, rare.

O. florida Salisb. (*Xanthoxalis brittoniae* Small, *X. colorea* Small).—Sandy hammock at junction of Big Cypress and Ichawaynochaway creeks, 14, rare; as in the preceding species the rarity of this plant is probably more apparent than real, and is due to insufficient collecting of a difficult group of closely related species.

O. recurva Ell. (*Xanthoxalis macrantha* (Trelease) Small, *X. recurva* (Ell.) Small).—Dry, sandy open woods, 14, 15, rare.

O. stricta L. (*Xanthoxalis stricta* (L.) Small).—Fields, waste places, and banks, 1, 9, 10, 11, 12, 14, infrequent.

O. violacea L. (*Ionoxalis violacea* (L.) Small). Violet wood sorrel.—Grassy banks, roadsides, and dry pinelands, 8, 11, 12, rare.

GERANIACEAE—Geranium Family

Geranium carolinianum L.—Roadsides, sandy fields, and waste places, common.

G. maculatum L. Wild cranesbill.—Rich woods in the northern part of the area, 5, 7, 11, infrequent.

LINACEAE—Flax Family

Linum floridanum (Planch.) Trel. (*Cathartolinum floridanum* (Planch.) Small). Yellow flax.—Moist pinelands and open, grassy areas, frequent.

L. medium (Planch.) Britt. (*Cathartolinum medium* (Planch.) Small).—Sandy pine-lands, open, grassy areas, and dry slopes, 7, 8, 14, 17, 18, infrequent.

L. striatum Walt. (*Cathartolinum striatum* (Walt.) Small).—Moist places, 1, 10, 12, rare.

RUTACEAE—Rue Family

**Poncirus trifoliata* (L.) Raf. Trifoliate-orange.—Waste ground in Albany, 9, rare.

Ptelea trifoliata L. Hop tree, wafer-ash.—Rich woods and banks and bluffs of the Flint and Chattahoochee rivers and their larger tributaries, frequent.

Xanthoxylum clava-herculis L. Prickly-ash, toothache tree.—Roadsides, fence-rows, old fields, and open, sandy woods on the Dougherty Plain, common.

SIMAROUBACEAE—Quassia Family

**Ailanthus altissima* (Mill.) Swingle.—Waste ground and river banks, 12, 17, rare.

MELIACEAE—Mahogany Family

**Melia azedarach* L. China-berry.—Roadsides, fence-rows, old fields, stream banks, and woods, abundant.

POLYGALACEAE—Milkwort Family

Polygala baldwinii Nutt. (*Pilostaxis baldwinii* (Nutt.) Small). White bachelor's button.—Low, open grassy meadow, 11 miles north of Newton, 14, rare.

P. boykinii Nutt.—Pinelands, limestone outcrops, and dry, wooded slopes, 1, 5, 14, 17, infrequent.

P. brevifolia Nutt.—Moist pineland 1 mile east of Recovery, 17, rare.

P. cruciata L. (*P. ramosior* (Nash) Small).—Moist pinelands, 1, 7, 10, 13, 17, infrequent.

P. cymosa Walt. (*Pilostaxis cymosa* (Walt.) Small).—Shallow cypress ponds and wet pinelands, frequent.

P. grandiflora Walt. (*Asemeia grandiflora* (Walt.) Small).—Dry pinelands, oak barrens, old fields, and open sandy woods, common.

P. incarnata L. (*Galypola incarnata* (L.) Nieuwl.).—Sandy pinelands, dry, oak woods, and sandy, open meadows, common.

P. leptostachys Shuttlw.—Dry, sandy, open area 11 miles northeast of Newton, 14, rare.

P. lutea L. (*Pilostaxis lutea* (L.) Small). Bachelor's button.—Moist pinelands and bogs, frequent.

P. mariana Mill.—Moist pinelands and open, grassy areas, 13, 14, rare.

P. nana (Michx.) DC. (*Pilostaxis nana* (Michx.) Raf.). Bachelor's button.—Dry pinelands and sandy oak woods, frequent.

P. nuttallii Torr. & Gray.—Open, grassy area eleven miles northeast of Newton, 14, rare.

P. polygama Walt.—Sandy pinelands and dry, open woods, frequent.

P. ramosa Ell. (*Pilostaxis ramosa* (Ell.) Small).—Moist pinelands, grassy margins of ponds, and moist, grassy meadows, frequent.

EUPHORBIACEAE—Spurge Family

Acalypha gracilens A. Gray.—Sandy soils of dry woods, waste places, old fields, margins of streams and ponds, and roadsides, common.

A. ostryaefolia Ridd.—Waste places, 1, 11, rare.

A. rhomboidea Raf.—Along the Chattahoochee River and other streams, frequent.

**A. setosa* A. Rich.—Waste places and stream banks, 9, 12, 15, rare.

(*Aleurites fordii* Hemsley. Tung.—Rare escape along streams and near tung orchards; spontaneous but probably not naturalized.)

Cnidoscolus stimulosus (Michx.) A. Gray (*Bivonea stimulosus* (Michx.) Raf.). Tread softly, spurge-nettle.—Dry pinelands, oak barrens, and open woods, common.

Croton argyranthemus Michx.—Dry, sandy soils of pinelands, oak barrens, and open oak-pine woods, common.

**C. capitatus* Michx. Hogwort.—Roadsides and railroad embankments, 6, 7, 10, 11, 12, 14, 17, infrequent.

C. elliotii Chapm.—Pinelands, 1, 7, rare.

C. glandulosa L. var. *septentrionalis* Muell. Arg.—Waste places, roadsides, dry fields, railroad embankments, and stream banks, common.

Crotonopsis linearis Michx.—Dry, sandy soil of oak barrens and pinelands, frequent.

Euphorbia commutata Engelm. (*Galarhoeus commutatus* (Engelm.) Small). Wood spurge.—Open woods at foot of bluff one mile north of Chattahoochee, Florida, 17, rare.

E. cordifolia Ell. (*Chamaesyce cordifolia* (Ell.) Small).—Dry sandy soil of oak barrens and stream banks, 1, 7, 9, 11, 14, 17, infrequent.

E. corollata L. (incl. *Tithymalus corollata* (L.) Small, *T. curtissii* (Engelm.) Small, *T. zinniflora* Small, *T. apocynifolia* Small, *T. paniculata* (Ell.) Small). Flowering spurge.

—Dry, sandy pinelands, oak barrens, wooded ravine slopes, and stream banks and bluffs, very common and variable.

E. dentata Michx. (*Poinsettia dentata* (Michx.) Small).—Waste ground under a railroad trestle near the Flint River, West Bainbridge, 17, rare.

E. floridana Chapm. (*Galarhoeus floridanus* (Chapm.) Small).—Dry, sandy oak barrens on edge of the escarpment west of Faceville and near Recovery, 17, rare.

E. gracilior Cronquist (*Tithymalopsis gracilis* (Ell.) Small).—Reported from 17 (Harper 1906), presumably on the Tifton Upland.

E. heterophylla L. (*Poinsettia heterophylla* (L.) Klotzsch & Garcke). Painted leaf, Wild poinsettia.—Waste grounds, 13, rare.

E. hyssopifolia L. (*Chamaesyce hyssopifolia* of the *Manual* in part).—Along a sidewalk in Albany, 9, rare.

E. maculata L. (*Chamaesyce maculata* (L.) Small, *E. supina* Raf.). Milk-purslane.—Roadsides, waste places, railroads, and sandy open woods, common.

**E. marginata* Pursh (*Lepadena marginata* (Pursh) Nieuwl.). Snow-on-the-mountain.—Escaped along roadsides, 13, rare.

E. nutans Lag. (*Chamaesyce hyssopifolia* of the *Manual* in part, *E. prestii* Guss., *E. maculata* sensu Wheeler and Fosberg).—Roadsides, waste places, and sandy fields, common.

E. prostrata Ait. (*Chamaesyce prostrata* (Ait.) Small, *E. chamaesyce* sensu Wheeler, not L.).—Waste places, 9, 10, rare.

**Manihot esculenta* Crantz (*Jatropha manihot* L.). Cassava.—Well-established in town dump along Spring Creek near Colquitt, 13; dumping operations since may have covered or otherwise destroyed the shrubs.

Phyllanthus carolinensis Walt.—Waste places, river banks, and moist pond margins, 9, 12, 15, 17, 18, infrequent.

**Ricinus communis* L. Castor-oil plant, castor bean.—Waste places and roadsides, frequent.

Sebastiania fruticosa (Bartr.) Fern. (*S. ligustrina* (Michx.) Muell. Arg.).—Moist hammocks, wooded bottoms, and banks of streams, common.

Stillingia aquatica Chapm. Corkwood.—Shallow water of cypress ponds and wet pine-lands, 1, 7, 10, 12, 13, 14, infrequent.

S. sylvatica L. Queen's root.—Dry, open, usually sandy woods and barrens, common.

Tragia betonicaefolia Nutt.—Sandy pinelands, 12, 13, 14, 17, 18, infrequent.

T. cordata Michx. (*T. macrocarpa* Willd.).—Rich, calcareous woods, 5, 7, 17, rare.

T. linearifolia Ell.—Dry sandy oak barrens and open oak-pine woods, 5, 17, rare.

T. urens L.—Dry, sandy pinelands, oak-pine woods, and oak barrens, frequent.

T. urticifolia Michx.—Dry, sandy woods and pinelands, 1, 5, 8, 9, 14, 15, infrequent.

CALLITRICHACEAE—Water Starwort Family

Callitriche deflexa A. Br. var. *austinii* (Engelm.) Hegelm. (incl. *C. terrestris* Raf., *C. peploides* Nutt.).—Wet sand, 17, rare.

C. heterophylla Pursh.—Shallow water of small ponds and streams, frequent.

ANACARDIACEAE—Sumac Family

Rhus copallina L. Dwarf sumac.—Dry, open woods, pinelands, and barrens, abundant.

R. glabra L. Smooth sumac.—Roadsides, old fields, and open woods, common.

R. radicans L. (*Toxicodendron radicans* (L.) Kuntze). Poison-ivy.—Swamps, woods, hammocks, thickets, and pond and stream margins, abundant.

R. toxicodendron L. (*Toxicodendron toxicodendron* (L.) Britt.). Poison-oak.—Dry pinelands, oak barrens, and oak woods, common.

R. vernix L. (*Toxicodendron vernix* (L.) Kuntze). Poison sumac, thunderwood.—Non-alluvial swamps, bogs, and seepage slopes, common.

CYRILLACEAE—Tyty Family

Cliftonia monophylla (Lam.) Sarg. Tyty.—Sandy, non-alluvial swamps, 6, 12, 17, rare.

Cyrilla racemiflora L. (incl. *C. parvifolia* Raf.). Tyty.—Wet pinelands, sandy swamps, and stream banks, common.

AQUIFOLIACEAE—Holly Family

Ilex ambigua (Michx.) Torr.—Sandy or mesic hammocks and sandy, open woods on the Dougherty Plain, frequent.

I. cassine L. Dahoon.—Sandy swamps, especially near spring-heads and along small streams on the Dougherty Plain between the Flint and Chattahoochee rivers, frequent.

I. coriacea (Pursh) Chapm. Large gallberry.—Sandy, non-alluvial swamps, bogs, and seepage slopes, common.

I. decidua Walt. (incl. *I. curtisii* (Fern.) Small). Possum-haw.—Wooded bottoms and banks of streams on the Dougherty Plain, common.

I. glabra (L.) A. Gray. Gallberry.—Poorly drained pinelands, boggy areas, and seepage slopes, common.

I. montana Torr. & Gray (incl. var. *mollis* (Gray) Britt., *I. beadlei* Ashe).—Rich woods, especially on ravine slopes and crests in the Red Hills, 5, 11, 12, infrequent.

I. myrtifolia Walt. Yaupon.—Shallow water of cypress ponds, common.

I. opaca Ait. Holly.—Hammocks, ravines, bluffs, and stream banks and bottoms, abundant.

I. verticillata (L.) A. Gray. Black-alder, winterberry.—Sandy swamps, 6, 12, rare.

I. vomitoria Ait. Cassena, yaupon.—Sandy hammocks and open, sandy woods near streams, frequent.

CELASTRACEAE—Stafftree Family

Euonymus americanus L. Strawberry bush.—Hammocks and rich woods, common.

E. atropurpureus Jacq. Wahoo, burning bush.—Banks and bluffs of the Chattahoochee River, 12, 17, rare.

STAPHYLEACEAE—Bladdernut Family

Staphylea trifolia L. Bladdernut.—Banks of the Chattahoochee River, 4, 12, 18, rare.

ACERACEAE—Maple Family

Acer barbatum Michx. (*Saccharodendron floridanum* (Chapm.) Nieuwl.). Sugar maple.—Hammocks and rich woods of bluffs, ravines, and stream banks, abundant.

A. leucoderme Small (*Saccharodendron leucoderme* (Small) Nieuwl.). Chalk maple.—Rich woods on ravine slopes in the Red Hills, 5, 11, rare.

A. negundo L. (*Negundo negundo* (L.) Karst.). Box-elder.—Banks of the Chattahoochee River, abundant.

A. rubrum L. (*Rufacer rubrum* Small, *R. carolinianum* (Walt.) Small, *R. drummondii* (H. & A.) Small). Red maple.—Moist places, especially swamps, stream and pond margins, moist woods, and moist pinelands, abundant.

A. saccharinum L. (*Argentacer saccharinum* (L.) Small). Silver maple.—Abundant along the banks of the Chattahoochee River; collected once along the Flint River at Newton, 14.

SAPINDACEAE—Soapberry Family

Aesculus parviflora Walt. Bottlebrush buckeye.—Rich woods of ravines and bluffs, 3, 11, 12, infrequent.

A. pavia L. Red buckeye, firecracker plant.—Hammocks and rich woods, common.

BALSAMINACEAE—Jewelweed Family

Impatiens biflora Walt. (*I. capensis* sensu Fern., prob. not Meerb.). Touch-me-not.—Wet woods, 2, 5, 11, 12, 18, infrequent.

RHAMNACEAE—Buckthorn Family

Berchemia scandens (Hill) K. Koch. Rattan vine, supplejack.—Moist or swampy woods, usually along streams, common.

Ceanothus americanus L. (incl. *C. intermedius* Pursh). Red root, New Jersey-tea.—Dry, open woods, common.

C. microphyllus Michx.—Dry pinelands and open, oak woods on the Dougherty Plain, common.

Rhamnus caroliniana Walt. Indian-cherry.—Rich, calcareous woods in the Red Hills, 11, 12, infrequent.

VITACEAE—Grape Family

Ampelopsis arborea (L.) Koehne. Pepper vine.—Moist or swampy woods, abundant; frequently a weed of roadsides.

A. cordata Michx.—Bottom woods and river banks, mostly along the Chattahoochee River, 9, 11, 12, 18, infrequent.

Parthenocissus quinquefolia (L.) Planch. Woodbine, Virginia creeper.—Moist woods, common.

Vitis aestivalis Michx. (incl. *V. rufoomentosa* Small). Wild grape, summer grape.—Woods, thickets and stream banks, common.

V. cinerea Engelm. Pigeon grape.—Stream banks, 10, 13, 14, 17, infrequent.

V. rotundifolia Michx. (*Muscadina rotundifolia* (Michx.) Small). Muscadine.—Woods, thickets, swamps, stream banks, hammocks, and roadsides, abundant.

V. vulpina L. (*V. cordifolia* Lam.). Frost grape.—Thickets and banks of rivers, 9, 12, 18, infrequent.

TILIACEAE—Linden Family

Tilia americana L. var. *heterophylla* (Vent.) Loud. (incl. *T. heterophylla* Vent., *T. caroliniana* Mill., *T. georgiana* Sarg., *T. floridana* (V. Engler) Small, etc.). Basswood, linden.—Rich woods of ravines, bluffs, bottoms, and stream banks, common.

MALVACEAE—Mallow Family

Callirhoe papaver (Cav.) A. Gray. Poppy mallow.—Dry, sandy pinelands and old fields, 15, 17, 18, rare.

Hibiscus aculeatus Walt.—Sandy pinelands on the Dougherty Plain, common.

H. incanus Wendl.—Moist ground in the southern part of the area, 15, 17, 18, infrequent.

H. militaris Cav.—Marshy places along streams, 4, 18, rare.

H. moscheutos L. (*H. oculiroseus* Britt.). Rose mallow.—Wet, grassy meadows and marshy places, 7, 8, 9, 10, 14, infrequent.

**Malvaviscus drummondii* Torr. & Gray. Wax mallow.—Escaped in waste places and on roadsides, rare.

Modiola caroliniana (L.) G. Don.—Waste places and roadsides, frequent.

Sida elliptica Torr. & Gray. Tea weed.—Roadsides, old fields, and sandy woods, 9, 12, 14, 18, infrequent.

**S. rhombifolia* L.—Roadsides and waste places, common.

**S. spinosa* L.—Reported as a weed in 1 (Harper 1900).

STERCULIACEAE—Chocolate Family

**Melochia corchorifolia* L.—Rare weed, 18.

THEACEAE—Camellia Family

Gordonia lasianthus (L.) Ellis. Loblolly-bay.—Springy woods at the foot of the bluff east of the Chattahoochee River near Hilton, 12, rare.

Stewartia malachodendron L. (also *Stuartia* L.). Silky camellia.—Dry, beech-magnolia hammock along Ichawaynochaway Creek west of Leary, 10, rare.

GUTTIFERAE—St. John's-wort Family

Ascyrum hypericoides L. (incl. *A. linifolium* Spach). St. Andrew's cross.—Open woods and sandy pinelands, very common.

A. pumilum Michx.—Pinelands on the Dougherty Plain, frequent.

A. stans Michx.—Moist, sandy soil of pinelands, bogs, and seepage slopes, common.

Hypericum adpressum Bart.—Low area between swamps of the Kioknee and Chickasawhatchee creeks west of Pretoria, 9, rare.

H. canadense L.—Moist sand, 8, 17, rare.

H. cistifolium Lam. (*H. opacum* Torr & Gray).—Moist pinelands, 1, 7, 13, infrequent.

H. densiflorum Pursh.—Boggy area on west side of Muckalee Creek 3 miles south of Americus, 1, rare.

H. denticulatum Walt. var. *acutifolium* (Ell.) Blake (*H. acutifolium* Ell.).—Common

in shallow water of cypress ponds and grassy limesink ponds and in wet or moist pinelands; infrequent in oak-pine woods.

H. drummondii (Grev. & Hook.) Torr. & Gray (*Sarothra drummondii* Grev. & Hook.).—Old fields, open sandy pinelands, and open bottomland along streams, 9, 11, 13, 14, 15, infrequent.

H. frondosum Michx. (*H. aureum* Bartr., not Lour.).—Banks of the Chattahoochee River, 4, 12, 18, infrequent.

H. galioides Lam. var. *galioides* (incl. *H. fasciculatum* Lam., *H. aspalathoides* Willd., *H. galioides* var. *reductum* Svenson).—Moist or wet pinelands, shallow cypress ponds, and sandy bogs, common.

H. galioides Lam. var. *pallidum* Mohr. (*H. ambiguum* of Small, possibly not Ell.).—Alluvial margins, banks, and wooded bottoms of streams on the Dougherty Plain, common. Probably better treated as a subspecies of *H. galioides*.

H. gentianoides (L.) B.S.P. (*Sarothra gentianoides* L.). Poverty weed.—Dry, sandy soil of old fields, roadsides, barrens, and open woods, common.

H. gymnanthum Engelm. and Gray.—Margin of small, intermittent pond 6 miles south of Albany, 9, rare.

H. microsepalum (Torr. & Gray) A. Gray (*Crookea microsepala* (Torr. & Gray) Small).—Moist, sandy pinelands, 10, 13, rare.

H. mutilum L. Dwarf St. John's-wort.—Wet, sandy places, especially pond and stream margins, moist pinelands, sandy swamps, bogs, and wet ravine bottoms, common.

H. myrtifolium Lam.—Moist, grassy meadows, moist pinelands, and shallow pineland ponds, 1, 7, 13, 14, 15, 17, infrequent.

H. nudiflorum Michx.—Along streams and on wooded ravine slopes, 10, 17, infrequent.

H. punctatum Lam. (incl. *H. pseudomaculatum* Bush).—Dry, open woods, pinelands, and old fields, frequent.

H. setosum L.—Moist pinelands and bogs, 1, 7, 12, 13, 17, infrequent.

H. tubulosum Walt. (*Triadenum petiolatum* (Walt.) Britt., *T. longifolium* Small, *H. tubulosum* var. *walteri* (Gmel.) Lott., *H. petiolatum* Walt. var. *tubulosum* (Walt.) Fern.).—Cypress ponds, wet pinelands, sandy swamps, and wet ravine bottoms, common.

H. virginicum L. (*Triadenum virginicum* (L.) Raf.). Marsh St. John's-wort.—Cypress ponds, sandy swamps, and bogs, common.

CISTACEAE—Rockrose Family

Helianthemum carolinianum (Walt.) Michx. (*Crocianthemum carolinianum* (Walt.) Spach). Rockrose, frostweed.—Dry pinelands and sandy open woods, frequent.

H. georgianum Chapm. (*Crocianthemum georgianum* (Chapm.) Barnh.).—Dry, sandy soil of stream banks, barrens, and open woods, 9, 14, 17, infrequent.

H. rosmarinifolium Pursh (*Crocianthemum rosmarinifolium* (Pursh) Barnh.).—Dry, sandy soil of roadsides, barrens, and stream banks, 7, 14, 17, infrequent.

Lechea leggettii Britt. & Hollick var. *ramosissima* Hodgdon. Pinweed.—Sandy pinelands, 8, 12, 15, 17, infrequent.

L. minor L.—Dry, sandy woods and pinelands, 8, 10, 12, 13, 17, infrequent.

L. patula Leggett.—Dry, sandy soil of oak barrens, dry pinelands, and open oak-pine woods, frequent.

L. villosa Ell.—Sandy old fields, dry pinelands, and dry, open woods, frequent.

VIOLACEAE—Violet Family

Hybanthus concolor (T. F. Forst.) Spreng. (*Cubelium concolor* (Forst.) Raf.). Green violet.—Rich, calcareous, wooded slopes near Greer's Cave, 5, rare.

Viola affinis LeConte. Violet.—Swamp along Pumpkin Creek a few miles northeast of Springvale, 5, rare.

V. hirsutula Brainerd.—Dry, rich or sandy woods, 11, 14, 15, 17, infrequent.

V. lanceolata L. (incl. *V. vittata* Greene).—Moist pinelands and boggy areas, frequent.

V. palmata L. (incl. *V. triloba* Schwein.).—Rich woods, 5, 11, 12, 17, infrequent.

V. papilionacea Pursh.—Rich or sandy woods of hammocks, ravines, bluffs, and stream banks, common.

V. pedata L. (incl. var. *lineariloba* DC.). Birdfoot Violet.—Dry, wooded slopes and open woods in the Red Hills and Fall Line Hills, 3, 5, 12, infrequent.

V. primulifolia L.—Moist or swampy woods and sandy bogs, frequent.

**Viola rafinesquii* Greene (*V. kitaibeliana* R. & S. var. *rafinesquii* (Greene) Fern.). Field pansy.—Roadsides, waste places, and dry fields in the Red Hills, 2, 6, 11, infrequent.

V. septemloba LeConte.—Sandy pinelands and open woods on the Dougherty Plain, frequent.

V. tripartita Ell. (incl. var. *glaberrima* (Ging.) Harper).—Rich woods on ravine slopes, 5, 17, rare.

V. villosa Walt.—Dry, sandy soil of hammocks, open woods, and stream banks, 6, 14, 15, 17, infrequent.

V. walteri House.—Rich or rocky woods, 5, 7, 11, 12, infrequent.

TURNERACEAE—Turnera Family

Piriqueta caroliniana (Walt.) Urban.—Sandy pinelands, open woods, and open, grassy places, common.

PASSIFLORACEAE—Passion Flower Family

Passiflora incarnata L. Maypop.—Roadsides, waste places, and cultivated or old fields, frequent.

P. lutea L. Yellow passion flower.—Rich or moist woods, common.

CACTACEAE—Cactus Family

**Opuntia ficus-indica* (L.) Mill. Prickly-pear.—Infrequent on roadsides on the Dougherty Plain; apparently an escape from cultivation although seen sometimes in places remote from human habitation.

O. pollardi Britt. & Rose. Common prickly-pear.—Dry, sandy open woods and barrens, common.

THYMELAEACEAE—Mezerum Family

Dirca palustris L. Leatherwood, moosewood.—Rich woods of ravines and bluffs, 11, 17, rare.

LYTHRACEAE—Loosestrife Family

Ammania coccinea Rottb.—Low places, 18, rare.

Decodon verticillatus (L.) Ell. Swamp loosestrife.—Cypress ponds and marshy areas, 1, 14, rare.

(**Lagerstroemia indica* L. Crape-myrtle.—Frequent along roadsides on old homesites and in vacant lots; doubtfully spontaneous.)

Lythrum curtissii Fern.—Infrequent in muddy swamps on the Dougherty Plain, 10, 13, 17; the type locality is "miry place in swamp near Leary, Curtiss 6876" (Fernald 1902).

L. lanceolatum Ell.—Wet places, especially ditches, moist pinelands, bottomlands, and pond and stream margins, frequent.

Rotala ramosior (L.) Koehne.—Wet, sandy, or sometimes muddy margins of ponds and streams and moist pinelands, common.

MELASTOMACEAE—Meadow Beauty Family

Rhexia alifanus Walt. (*R. glabella* Michx.). Meadow beauty.—Moist pinelands and boggy or moist, open, grassy places, common.

R. aristosa Britt.—Moist pinelands and margins of pineland ponds or grassy, limesink ponds, 1, 7, 9, 10, 14, infrequent.

R. ciliosa Michx.—Moist pinelands and bogs, frequent.

R. cubensis Griseb.—Moist pinelands, moist, open, grassy areas, and pond margins, 12, 14, 17, infrequent.

R. lanceolata Walt.—Moist pinelands, moist, open places, and wet margins of pineland ponds, infrequent.

R. lutea Walt.—Moist pinelands, 12, 13, rare.

R. mariana L. (incl. *R. nashii* Small).—Moist, sandy places, 1, 4, 12, 14, 17, infrequent.

R. virginica L. (incl. *R. stricta* Pursh).—Moist pinelands, shallow margins of ponds, open, grassy meadows, and springy or boggy places, common.

ONAGRACEAE—Evening-primrose Family

- Gaura angustifolia* Michx.—Roadsides and railroad embankments, 17, 18, rare.
G. biennis L.—Roadsides and waste places, 9, rare.
G. filipes Spach (*G. michauxii* Spach).—Dry, sandy soil of pinelands, oak barrens, and dry, open woods, common.
 **G. parviflora* Dougl. ex Hook.—Waste ground, Albany, 9, rare.
Jussiaea decurrens (Walt.) DC. Primrose-willow.—Wet places, especially pond and stream margins, wet ravine bottoms, and sloughs, common.
J. leptocarpa Nutt.—Ditches and marshy places, 1, 12, 17, infrequent.
Ludwigia alternifolia L. Seedbox.—Wet places, especially wet ravine bottoms, ditches, sandy swamps, and wet woods, common.
L. arcuata Walt. (*Ludwigiantha arcuata* (Walt.) Small).—Wet, sandy margins of ponds in the southernmost part of the area, 17, 18, rare.
L. glandulosa Walt.—Shallow water of ponds and streams on the Dougherty Plain, common.
L. hirtella Raf.—Moist pinelands and bogs, common.
L. linearis Walt.—Moist or wet pinelands and shallow pineland ponds, common.
L. linifolia Poir.—Moist pinelands in the vicinity of Mossy Pond, 14, rare.
L. microcarpa Michx.—Wet, sandy soil of moist pinelands, pond and stream margins, and ditches, common.
L. natans Ell. (*Isnardia repens* (Sw.) DC.).—Shallow water of streams and ponds, 2, 7, 9, 12, 14, infrequent.
L. palustris (L.) Ell. (*Isnardia palustris* L. and vars.). Water-purslane.—Wet places, especially pond and stream margins, common.
L. pilosa Walt.—Wet or moist, sandy pinelands and shallow cypress ponds, common.
L. spathulata Torr. & Gray (*Isnardia spathulata* (T. & G.) Small).—Wet margin of Douglas Lake, 17, rare.
L. sphaerocarpa Ell.—Shallow cypress ponds and wet pinelands, frequent.
L. suffruticosa Walt.—Shallow, grassy ponds, frequent.
L. virgata Michx. (incl. *L. maritima* Harper).—Moist, sandy pinelands, frequent.
Oenothera biennis L. Evening-primrose.—Old fields, roadsides, and dry, open woods, common.
O. fruticosa L. (*Kneiffia fruticosa* (L.) Raimann, *K. arenicola* Small). Sundrop.—Dry, sandy pinelands and dry, open oak woods, frequent.
O. laciniata Hill (*Raimannia laciniata* (Hill) Rose).—Roadsides, sandy old fields, and waste places, common.
 **O. rhombipetala* Nutt. (incl. *Raimannia curtisii* Rose).—Rare introduction from the West, 17.
 **O. speciosa* Nutt. (*Hartmannia speciosa* (Nutt.) Small). Primrose.—Roadsides and vacant lots, frequent.

HALORAGACEAE—Water-milfoil Family

- **Myriophyllum brasiliense* Camb. (*M. proserpinacoides* Gill.). Water feather, parrot's feather.—Ditches, small ponds, spring-fed streams, and swamps, 7, 9, 11, 12, 15, 18, infrequent.
M. heterophyllum Michx.—Ponds, sloughs, and sluggish streams, common.
M. laxum Shuttlw.—Ponds in the southern part of the area, 12, 17, rare.
M. pinnatum (Walt.) B.S.P.—Muddy margins and shallow water of ponds in the southern half of the area, 13, 18, rare.
Proserpinaca palustris L. Mermaid weed.—Ponds, sloughs, swamps, and wet pinelands, frequent.
P. pectinata Lam.—Wet pinelands, cypress ponds, and ditches, common.

ARALIACEAE—Ginseng Family

- Aralia spinosa* L. Devil's walking stick, Hercules club.—Hammocks, ravines, and moist woods along streams, common.
Panax quinquefolius L. Ginseng.—Rich woods of ravines and bluffs in the Red Hills, 5, 11, rare.

UMBELLIFERAE—Carrot Family

**Ammi majus* L. Bishop's weed.—Ditch by roadside on the outskirts of Morgan, 10, rare.

Angelica dentata (Chapm.) C. & R.—Sandy pinelands, 8, 17, rare.

A. venenosa (Greenway) Fern. (*A. villosa* (Walt.) B.S.P.). Hairy angelica.—Dry woods and thickets, frequent.

**Apium leptophyllum* (Pers.) F. Muell. (*Cyclospermum ammi* (L.) Britt.).—Roadsides and waste places, frequent.

Centella erecta (L.f.) Fern. (*C. repanda* (Pers.) Small).—Moist pinelands, wet, grassy meadows, and shallow ponds, common.

Chaerophyllum tainturieri Hook. (incl. *C. floridanum* (C. & R.) Bush). Cherfil.—Roadsides, waste places, vacant lots, and pecan groves, frequent.

Cicuta maculata L. var. *curtissii* (C. & R.) Fern. (*C. curtisii* C. & R., *C. mexicana* C. & R.). Water-hemlock.—Swampy woods along streams, 7, rare.

Cryptotaenia canadensis (L.) DC. (*Deringa canadensis* (L.) Kuntze). Honewort.—Moist woods along the Chattahoochee River, 12, 18, rare.

Daucus pusillus Michx. Wild carrot.—Dry roadsides, old fields, and waste places, 1, 10, 11, 13, 14, 17, 18, infrequent.

Eryngium baldwinii Spreng. Button snakeroot.—Moist margin of a small pond in open pine woods a few miles northeast of Newton, 14, rare.

E. integrifolium Walt.—Sandy bogs, 12, 17, rare.

E. ludovicianum Morong.—Moist pinelands, 1, 8, 10, rare.

E. prostratum Nutt.—Wet places, especially wet margins of ponds, common.

E. ravenelii A. Gray (*E. aquaticum* L. var. *ravenelii* Math. & Const.).—Moist pinelands, infrequent.

E. synchaetum (A. Gray) Rose.—Sandy pinelands and open, grassy areas, common.

E. yuccifolium Michx. (*E. aquaticum* of the *Manual*). Button snakeroot.—Moist or dry, sandy, alluvial, or rocky soils, usually in open places, 5, 6, 8, 10, 13, 14, 17, infrequent.

Hydrocotyle umbellata L. Water pennywort.—Shallow water and wet margins of ponds, moist pinelands, ditches, and swampy places along streams, frequent.

H. verticillata Thunb. (incl. *H. canbyi* C. & R., *H. australis* C. & R.).—Wet places, especially the wet margins of ponds, streams, ditches, and swamps, common.

Oxypolis filiformis (Walt.) Britt. (incl. *O. canbyi* (C. & R.) Fern.).—Shallow cypress ponds and wet pinelands, frequent. The corky-winged form, *O. filiformis* var. *canbyi* C. & R. was found in moist pinelands 6 miles northwest of Leesburg, 7.

O. rigidior (L.) Raf.—Wet woods, swamps, and bogs, 1, 10, 12, infrequent.

Ptilimnium capillaceum (Michx.) Raf. Mock bishop's weed.—Wet places on the Dougherty Plain, frequent.

Sanicula canadensis L. (incl. *S. floridana* Bicknell). Sanicle, black snakeroot.—Rich or dry woods, common.

S. gregaria Bicknell.—Rich woods, 5, 7, 11, 12, 17, infrequent.

S. marilandica L.—Rich or dry, open woods, 5, 10, 12, 14, 17, infrequent.

S. smallii Bicknell.—Rich woods, 11, 12, 17, infrequent.

Sium suave Walt. (*S. cicutaefolium* Schrank). Water-parsley.—Shallow water of swamps, 9, 14, rare.

Spermolepis divaricata (Walt.) Britt.—Dry, sandy soil, 9, 17, rare.

Thaspium barbinode (Michx.) Nutt. var. *chapmanii* C. & R. (*T. chapmanii* (C. & R.) Small).—Rich or dry, calcareous woods, 5, 7, 12, infrequent.

T. trifoliatum (L.) A. Gray.—Rich, rocky, or dry woods of stream banks, bluffs, and ravines, 7, 8, 9, 11, 12, infrequent.

Zizia aurea (L.) W.D.J. Koch. Golden Alexanders.—Rich, moist or dry woods in the Red Hills, 5, 11, rare.

Z. trifoliata (Michx.) Fern. (incl. *Z. arenicola* Rose, *Z. bebbii* (C. & R.) Britt.).—Rich woods of ravines, bluffs, and stream banks, 11, 12, 14, 17, infrequent.

CORNACEAE—Dogwood Family

Cornus alternifolia L.f. (*Svida alternifolia* (L.f.) Small). Pagoda dogwood.—Rich woods of ravines, 5, 11, 17, infrequent.

C. amomum Mill. (*Svida amomum* (Mill.) Small). Kinnikinnik, silky dogwood.—Banks of streams, 1, 12, 18, infrequent.

C. asperifolia Michx. (*Svida microcarpa* (Nash) Small, not *S. asperifolia* of Small).—Moist woods along streams, common.

C. florida L. (*Cynoxylon floridum* (L.) Raf.). Flowering dogwood.—Dry, open woods, common.

C. foemina Mill. (*Svida stricta* (Lam.) Small, not *S. femina* of Small).—Moist or swampy woods, usually along streams, common.

NYSSACEAE—Sour Gum Family

Nyssa aquatica L. (*N. uniflora* Wangeh.). Tupelo gum.—Common in alluvial swamps and along margins of streams on the Dougherty Plain; not seen in the watershed of the Chattahoochee River.

N. ogeche Bartr. Ogeche-line.—Infrequent along streams on the Dougherty Plain; not seen along the Chattahoochee River, 14, 15, 18.

N. sylvatica Marsh. var. *sylvatica*. Sour gum, black gum.—Dry woods, common.

N. sylvatica Marsh. var. *biflora* (Walt.) Sarg. (*N. biflora* Walt.). Water gum, Black gum.—Shallow pineland and cypress ponds, sandy swamps, and margins of permanent ponds, abundant.

ERICACEAE—Heath Family

Chimaphila maculata (L.) Pursh. Spotted wintergreen.—Sandy thickets along Spring Creek west of Holt, 10, rare.

Clethra tomentosa Lam.—Moist pinelands, cypress ponds, and sandy swamps, common.

Epigaea repens L. Mayflower, trailing-arbutus.—Living material transplanted from Providence Canyons, 3, seen by W. H. Duncan (personal communication), rare.

Gaylussacia dumosa (Andr.) T. & G. (*Lasiococcus dumosus* (Andr.) Small). Dwarf Huckleberry.—Sandy pinelands, oak barrens, and dry, open woods, common.

G. frondosa (L.) T. & G. (*Decachaena frondosa* (L.) T. & G.). Dangleberry.—Moist pinelands, 7, 12, rare.

G. mosieri Small (*Lasiococcus mosieri* Small).—Sandy bogs, 12, 17, rare.

G. nana (A. Gray) Small (*Decachaena nana* (A. Gray) Small).—Sandy pinelands, 8, 13, 15, 17, infrequent.

G. tomentosa (Pursh) Small (*Decachaena tomentosa* (Pursh) Small).—Moist pinelands and sandy swamps, frequent.

Kalmia latifolia L. Ivy, calico bush, mountain-laurel.—Ravines, wooded slopes of bluffs, and sandy banks of branches and creeks, frequent.

Leucothoe axillaris (Lam.) D. Don. Fetter bush.—Sandy swamps and bogs, branches, seepage slopes, and wet woods, common.

L. racemosa (L.) A. Gray (*Eubotrys racemosa* (L.) Nutt., *E. elongata* Small).—Cypress ponds, moist pinelands, bogs, sandy swamps, seepage slopes, and branches, common.

Lyonia ligustrina (L.) DC. (*Arsenococcus ligustrinus* (L.) Small, *A. frondosus* (Pursh) Small). Maleberry.—Moist, sandy thickets, bogs, sandy swamps, and seepage slopes, frequent.

L. lucida (Lam.) K. Koch (*Desmothamnus lucidus* (Lam.) Small). Hurrah bush, fetter bush.—Moist pinelands, cypress ponds, sandy swamps, and bogs, common.

Monotropa hypopithys L. (*Hypopitys lanuginosa* (Michx.) Nutt.). Pine-sap.—Sandy thickets and woods, 10, 12, rare.

M. uniflora L. Indian pipe.—Sandy or rich, moist or dry woods, frequent.

Oxydendrum arboreum (L.) DC. Sourwood.—Hammocks, ravines, and wooded slopes of bluffs, common.

Pieris phyllireifolius (Hook.) DC. (*Ampelothamnus phyllireifolius* (Hook.) Small).—Vine on *Taxodium ascendens* in cypress ponds, 10, 12, 13, infrequent.

Rhododendron canescens (Michx.) Sweet (incl. *Azalea canescens* Michx., *A. austrina* Small, *A. alabamensis* (Rehder) Small). Honeysuckle, azalea.—Woods, mostly near streams, common.

R. minus Michx.—Ravines and bluffs in the Red Hills, 3, 5, 11, 12, infrequent.

R. prunifolium (Small) Millais (*Azalea prunifolia* Small).—Moist ravines in the Red Hills, 5, 11, rare. This striking and distinct azalea, bearing crimson flowers in midsummer, is one of the most characteristic plants of the Red Hills.

R. serrulatum (Small) Millais (*A. serrulata* Small). Clammy azalea.—Bogs, 1, 12, 17, infrequent.

Vaccinium amoenum Ait. (*Cyanococcus amoenus* Small in part).—Hammocks and moist or boggy woods, 1, 10, 12, infrequent.

V. arboreum Marsh. (*Batodendron arboreum* (Marsh.) Nutt.). Sparkleberry.—Dry, open woods, common.

V. caesium Greene (*Polycodium floridanum* (Nutt.) Greene, *P. ashei* Harb.). Deerberry.—Dry pinelands, sandy barrens, hammocks, and dry oak woods, frequent.

V. corymbosum L. (incl. *Cyanococcus corymbosus* (L.) Rydb., *C. amoenus* Small in part, *C. atrococcus* (A. Gray) Small, *V. ashei* Reade, *V. australe* Small, *V. marianum* Watson). High-bush blueberry.—Wet or swampy woods, sandy swamps, and bogs, common.

V. elliotii Chapm. (*Cyanococcus elliotii* (Chapm.) Small).—Hammocks, dry, sandy woods, ravines, and bluffs, common.

V. fuscatum Ait. (*Cyanococcus fuscatus* (Ait.) Small, *C. holophyllus* Small).—Sandy woods near Mossy Pond, 14, rare.

V. melanocarpum C. Mohr. (*Polycodium melanocarpum* (C. Mohr) Small). Gooseberry.—Dry, sandy woods and pinelands, frequent.

V. myrsinites Lam. (*Cyanococcus myrsinites* (Lam.) Small).—Dry, sandy, open woods and pinelands, common.

V. stamineum L. (*Polycodium stamineum* (L.) Greene, *P. neglectum* Small). Deerberry.—Dry, open woods, frequent.

V. tenellum Ait. (*Cyanococcus tenellus* (Ait.) Small).—Moist pinelands, 10, 12, rare.

V. virgatum Ait. (*Cyanococcus virgatus* (Ait.) Small).—Moist, sandy, open woods, 9, 10, 12, infrequent.

PRIMULACEAE—Primrose Family

Centunculus minimus L. Chaffweed.—Moist sand or mud on the Dougherty Plain, 10, 12, 14, 17, 18, infrequent.

Lysimachia ciliata L. (*Steironema ciliatum* (L.) Raf.). Fringed loosestrife.—Along Coolewahee Creek at Newton, 14, rare.

L. lanceolata Walt. (incl. *Steironema lanceolatum* (Walt.) A. Gray, *S. heterophyllum* (Michx.) Raf., *S. hybridum* (Michx.) Raf.).—Moist, sandy thickets and stream banks, 10, 12, rare.

Samolus parviflorus Raf. (*S. floribundus* H.B.K.). Water-pimpernel.—Wet margins of streams and ponds, frequent.

SAPOTACEAE—Sapodilla Family

Bumelia lanuginosa (Michx.) Pers. subsp. *lanuginosa*. Shittimwood.—Dry, open woods, especially in sandy hammocks and on ravine slopes, stream banks, and bluffs, common.

B. lycioides (L.) Pers.—Banks of the Chattahoochee River, frequent.

B. reclinata (Michx.) Vent.—Moist sandy, open places on the Dougherty Plain, frequent.

B. thornei Cronquist.—Infrequent on the Dougherty Plain in sandy, moist, open meadows or woods, 10, 12, 14, the entire known range (Cronquist 1949).

EBENACEAE—Ebony Family

Diospyros virginiana L. Persimmon.—Old fields, fence rows, roadsides, stream banks, woods, hammocks, and pinelands, abundant.

SYMPLOCACEAE—Sweetleaf Family

Symplocos tinctoria (L.) L'Her. Sweet leaf, horse sugar.—Hammocks and rich woods of ravines and bluffs, common.

STYRACACEAE—Storax Family

Halesia carolina Ellis (incl. *H. parviflora* Michx.) Silverbell, possumwood.—Rich woods of stream banks, moist hammocks, and ravine slopes, frequent.

H. diptera Ellis. Snowdrop tree, cowlicks.—Rich woods of ravines, bluffs, and stream banks, common.

Styrax americana Lam. (incl. *S. pulverulenta* Michx.). Storax.—Swampy margins of ponds and streams, very common.

S. grandifolia Ait.—Dry woods in hammocks and ravines and on bluffs and stream banks, frequent.

OLEACEAE—Olive Family

Chionanthus virginicus L. Fringe tree, graybeard, old man's beard.—Stream banks and moist or dry woods of hammocks, ravines, and bluffs, common.

Forestiera acuminata (Michx.) Poir.—Stream banks and bottoms and margins of fluctuating ponds in the southern part of the area. 15, 17, 18, infrequent.

F. ligustrina (Michx.) Poir.—Banks of streams on the Dougherty Plain, frequent.

Fraxinus americana L. White ash.—Rich woods of ravine slopes, bluffs, bottoms, moist hammocks, and stream banks, common.

F. biltmoreana Beadle.—Rich woods in the Red Hills, 5, 11, rare.

F. caroliniana Mill. (incl. *F. pauciflora* Nutt.). Water ash, pop ash.—Swamps and margins of streams on the Dougherty Plain, common; not observed in the watershed of the Chattahoochee River.

F. hybrida Linglesheim (perhaps *F. floridana* Sarg.).—Shallow water of Big Cypress Creek, two miles west of the Emory University Field Station, 14, rare.

F. pennsylvanica Marsh. (incl. *F. lanceolata* Borkh., *F. darlingtoniana* Britt.).—Red ash, green ash.—Alluvial swamps, sloughs, bottoms, and banks of streams, frequent.

(**Jasminum mesnyi* Hance (*J. primulinum* Hemsl.). Jasmine.—Rare escape from cultivation.)

(**Ligustrum lucidum* Ait. Privet.—Rarely spontaneous in vacant lots and on roadsides.)

**L. sinense* Lour. Chinese privet.—Vacant lots, waste places, roadsides, and stream banks, 6, 9, 10, 12, 14, 15, 17, infrequent.

Osmanthus americanus (L.) A. Gray (*Amarolea americana* (L.) Small). Devil wood, wild-olive.—Hammocks and rich woods of ravine slopes, bluffs, and stream banks, very common.

LOGANIACEAE—Logania Family

Cynoctonum mitreola (L.) Britt. Miterwort.—Moist places, especially wet borders of ponds, streams, and swamps, common.

C. sessilifolium (Walt.) J. F. Gmel. (incl. *C. angustifolium* (T. & G.) Small).—Moist pinelands and moist, sandy, open places, frequent.

Gelsemium sempervirens (L.) Ait. f. Yellow-jasmine.—Hammocks, ravines, bluffs, and pond and stream margins, very common.

Polypremum procumbens L.—Sandy soil of pond and stream margins, pinelands, fields, and roadsides, common.

Spigelia marilandica L. Indian-pink, pinkroot.—Rich woods of ravines, bluffs, and stream banks, common.

GENTIANACEAE—Gentian Family

Bartonia paniculata (Michx.) Robinson (*B. lanceolata* Small).—Moist pinelands and bogs, 12, 13, 17, rare.

B. virginica (L.) B.S.P.—Moist pinelands and bogs, 1, 13, 17, rare.

Gentiana saponaria L. (incl. *Dasystephania saponaria* (L.) Small, *D. parvifolia* (Chapm.) Small, *D. latifolia* (Chapm.) Small). Soapwort gentian.—Along streams and in wet woods and swamps, 12, 15, infrequent.

G. villosa L. (*Dasystephania villosa* (L.) Small).—Dry, open woods and pinelands, 5, 14, 17, 18, infrequent.

Sabatia angularis (L.) Pursh. Rose-pink.—Dry, open woods and sandy, open places, frequent.

S. calycina (Lam.) Heller.—Moist woods and wet margins of streams and ponds on the Dougherty Plain, 7, 10, 13, 14, 17, infrequent.

S. campanulata (L.) Torr. var. *gracilis* (Michx.) Fern.—Moist pinelands and moist meadows, frequent.

S. decandra (Walt.) Harper.—Shallow cypress ponds and wet pinelands, frequent.

S. difformis (L.) Druce.—Moist pinelands and sandy bogs just southeast of the escarpment, 17, rare.

S. foliosa Fern.—Shallow cypress ponds and wet, sandy margins of streams, 12, 14, 15, 17, infrequent.

S. gentianoides Ell. (*Lapitheia gentianoides* (Ell.) Griseb.).—Moist pinelands, 7, 8, 10, infrequent.

S. macrophylla Hook.—Moist pinelands and bogs, 1, 8, rare.

S. paniculata (Michx.) Pursh.—Moist pinelands, 1, 7, 15, rare.

MENYANTHACEAE—Buckbean Family

Nymphoides aquatica (Walt.) Kuntze. Floating heart.—Permanent ponds, frequent.

N. cordata (Ell.) Fern. (*N. lacunosa* (Vent.) Kuntze).—Shallow water of ponds and borrow-pits, frequent.

APOCYNACEAE—Dogbane Family

Amsonia ciliata Walt. (incl. var. *filifolia* Wood). Blue dogbane, blue star.—Dry, sandy, open woods, frequent.

A. rigida Shuttlew.—Shallow water and wet margins of ponds and wet pinelands, frequent.

A. tabernaemontana Walt. (incl. *A. salicifolia* Pursh).—Rich woods of ravines, bluffs, stream banks, and bottoms, frequent.

Apocynum cannabinum L. Dogbane, Indian hemp.—Dry, sandy roadsides, 1, 5, 9, 10, 14, infrequent.

Trachelospermum difforme (Walt.) A. Gray.—Stream banks, bottoms, sloughs, and swamps, common.

**Vinca major* L. Periwinkle.—Dry woods 9 miles east of Cuthbert, 5, rare.

ASCLEPIADACEAE—Milkweed Family

Asclepias amplexicaulis J. E. Smith. Milkweed.—Dry, sandy soil of fields, roadsides, and open woods, frequent.

A. cinerea Walt.—Slightly moist pinelands, 7, 10, 12, 13, 14, 15, infrequent.

A. connivens Baldwin. (*Anantherix connivens* (Baldw.) A. Gray).—Moist pinelands, 8, 13, rare.

A. humistrata Walt.—Dry, deep sand of pinelands and oak barrens, frequent.

A. lanceolata Walt.—Moist pinelands, 1, 7, 9, 10, 12, 13, 14, 15, infrequent.

A. longifolia Michx. (*Acerates floridana* (Lam.) A. Hitchc.).—Moist pinelands and grassy meadows, 1, 7, 9, 10, 13, 14, 15, infrequent.

A. michauxii Decne.—Moist pinelands, 10, 12, 13, 14, 17, infrequent.

A. obovata Ell.—Dry pinelands, oak barrens, and sandy fields, 7, 8, 12, 15, 17, 18, infrequent.

A. pedicellata Walt. (*Podostigma pedicellata* (Walt.) Vail).—Moist pinelands, 13, 14, rare.

A. perennis Walt.—Alluvial swamps and bottoms and margins of streams, frequent.

A. rubra L. (incl. *A. laurifolia* Michx.).—Low grounds near Muckalee Creek, Americus, rare.

A. tuberosa L. (incl. *A. decumbens* L., *A. rolfsii* Britt.). Butterfly weed.—Dry, sandy pinelands, oak barrens, open oak woods, and fields, common.

A. variegata L. (*Biventraria variegata* (L.) Small).—Open, usually dry woods of ravines, bluffs, and stream banks, common.

A. verticillata L.—Dry, sandy or rocky, open woods and barrens, frequent.

A. viridiflora Raf. (*Acerates viridiflora* (Raf.) Eaton).—Dry, exposed places, 1, 5, 17, rare.

Cyanchum laeve (Michx.) Pers. (*Gonolobus laevis* Michx., *Ampelamus albidus* (Nutt.) Britt.). Sandvine.—Open bottomland along the Chattahoochee River near Neal's Landing bridge, 18, rare.

Gonolobus suberosus (L.) R. Br. (*Vincetoxicum suberosum* (L.) Britt.). Angle pod.—Stream banks, wooded bottoms, and moist thickets, frequent.

Matelea alabamensis (Vail) Woodson (*Cyclodon alabamense* (Vail) Small). Spiny pod.—Dry, rich woods of ravine slopes, 11, 12, 17, rare. This species, previously known only from Alabama, is to be expected also in western Florida.

M. carolinensis (Jacq.) Woodson ? (*Odontostephana carolinensis* (Jacq.) Alex.).—Wooded slopes of ravines, 11, 17, rare. Since the only specimens found of this plant are sterile, their identification is not certain.

CONVOLVULACEAE—Morning Glory Family

Breweria aquatica (Walt.) A. Gray (*Stylisma aquatica* (Walt.) Chapm., *B. michauxii* Fern. & Schubert).—Wet margins of shallow pineland ponds, frequent.

B. humistrata (Walt.) A. Gray (*Stylisma humistrata* (Walt.) Chapm.).—Dry, sandy woods and pinelands, frequent.

B. patens (Desr.) Fern. (*Stylisma trichosanthes* (Michx.) House, *B. aquatica* Fern. & Schubert, not as to basonym (*Convolvulus aquaticus* Walt.)).—Dry, sandy barrens and pinelands, frequent.

B. pickeringii (Torr.) A. Gray (*Stylisma pickeringii* (Torr.) A. Gray).—Fossil Dunes in East Albany, 9, rare.

Convolvulus sepium L. var. *repens* (L.) A. Gray (*C. repens* L.). Bindweed—Fields and dry, open woods, 12, rare.

Cuscuta campestris Yuncker. Dodder.—Fields, waste places, and roadbanks, 9, 11, 12, rare.

C. compacta Juss.—On many species of woody and deciduous plants, mostly in wet woods, common.

C. gronovii Willd.—On herbaceous plants in low woods along streams, 7, 12, 18, infrequent.

C. indecora Choisy.—Open, sandy pinelands and fields, 8, 9, rare.

C. obtusiflora HBK. var. *glandulosa* Engelm. (*C. glandulosa* Small).—On *Polygonum hydropiperoides* Michx. in a small, intermittent pond 6 miles south of Albany, 9, rare.

C. pentagona Engelm. (*C. arvensis* Beyr.).—Pinelands, open woods, and grassy meadows, 10, 11, 14, rare.

Dichondra repens Forst. (incl. *D. carolinensis* Michx.).—Moist, open places, grassy roadsides, and lawns, common.

Ipomoea carolina (L.) Pursh (*I. trichocarpa* Ell.).—Roadsides and waste places, 9, 10, 14, infrequent.

**I. coccinea* L. (*Quamoclit coccinea* (L.) Moench.). Red morning-glory.—Fields, roadsides, and waste places, frequent.

**I. dissecta* Jacq. (*Operculina dissecta* (Jacq.) House).—Waste places in towns, 15, 17, rare.

**I. hederacea* (L.) Jacq. (*Pharbitis hederacea* (L.) Choisy, *P. barbiger* (Sims) G. Don).—Cultivated fields, roadsides, and waste places, 5, 9, 11, 12, 14, infrequent.

I. lacunosa L.—Along streams, 12, 15, rare.

I. pandurata (L.) G. F. W. Mey. Wild-potato vine.—Dry, open woods, pinelands, roadsides, and fields, common.

**I. purpurea* (L.) Roth (*Pharbitis purpurea* (L.) Voigt.). Morning glory.—Waste places in towns, 1, 9, 10, 13, 18, infrequent.

**I. quamoclit* L. (*Quamoclit quamoclit* (L.) Britt.). Cypress vine.—Roadsides, fences, fields, and waste places, frequent.

**Jacquemontia tamnifolia* (L.) Griseb. (*Thyella tamnifolia* (L.) Raf.).—Fields, roadsides, and waste places, common.

POLEMONIACEAE—Phlox Family

Phlox amoena Sims. Hairy phlox.—Dry, sandy pinelands and open oak woods, 1, 5, 7, 10, 14, infrequent.

P. divaricata L. Blue phlox.—Rich woods, 5, 11, 12, 17, infrequent.

**P. drummondii* Hook. Annual phlox.—Vacant lot in Fort Gaines, 11, rare.

P. floridana Benth.—Dry, sandy pinelands, oak woods, and oak barrens, frequent.

P. glaberrima L. (incl. *P. carolina* L.). Smooth phlox.—Rich or sandy, moist or dry, open woods, frequent.

P. pilosa L.—Dry, open, often sandy woods, frequent.

HYDROPHYLLACEAE—Waterleaf Family

Hydrolea corymbosa Macbride (*Nama corymbosum* (Macbride) Kuntze).—Shallow water or wet sand of wet pinelands, cypress ponds, and borrow-pits, 10, 12, 13, infrequent.

H. ovata Nutt. (*Nama ovatum* (Nutt.) Britt.).—Shallow water of pineland ponds and borrow-pits, frequent.

H. quadrivalvis Walt. (*Nama quadrivalve* (Walt.) Kuntze).—Shallow woodland ponds and shallow margins of larger permanent ponds, frequent.

Nemophila microcalyx (Nutt.) F. & M.—Moist, alluvial woods along the Chattahoochee River, 11, 12, 18, rare.

Phacelia dubia (L.) Trelease.—Sandy field between Kolomoki Indian Mounds north of Blakely, 12, rare.

BORAGINACEAE—Borage Family

Cynoglossum virginianum L. Wild comfrey.—Rich woods in the Red Hills, 5, 11, 12, infrequent.

**Heliotropium anchusaefolium* Poir. (*Cochranea anchusaefolium* (Poir.) Guerke).—Roadsides and waste places, 5, 10, 11, 14, 17, infrequent.

**H. indicum* L. (*Tiaridium indicum* (L.) Lehm.).—Muddy margins of streams and waste places, 1, 9, 12, 13, 14, 17, 18, infrequent.

Lihospermum carolinense (Walt.) MacM. (*Batschia carolinensis* (Walt.) G. F. Gmel.). Puccoon.—Dry, sandy pinelands and barrens and clayey roadsides, frequent.

L. tuberosum Rugel.—Calcareous, wooded banks and hillsides, 7, rare.

Myosotis macrosperma Engelm. Forget-me-not.—Moist woods and bottoms along streams, 5, 11, 12, 18, infrequent.

M. virginica (L.) B.S.P. (*M. verna* Nutt.).—Waste places and dry fields, 11, 17, rare.

Onosmodium virginianum (L.) A. DC. False gromwell.—Dry, open woods, pinelands, and roadsides, frequent.

VERBENACEAE—Vervain Family

Callicarpa americana L. French-mulberry, beauty berry.—Hammocks, pinelands, thickets, and dry, open woods, abundant.

**Clerodendron indicum* (L.) Kuntze (*Siphonanthus indicus* L.).—Turk's turban.—Roadsides and waste places, 13, 14, 15, infrequent escape.

**Lantana camara* L. (incl. var. *mista* (L.) Bailey). Lantana.—Waste places and roadsides, 5, 9, 11, 13, 14, 17, 18, infrequent.

**L. montevidensis* (Spreng.) Briq. (*L. sellowiana* Link & Otto).—Roadsides, woods, and thickets, 12, 17, rare.

Lippia lanceolata Michx. (*Phyla lanceolata* (Michx.) Greene). Fog fruit.—Banks of the Chattahoochee River, 12, 18, infrequent.

L. nodiflora (L.) Michx. (*Phyla nodiflora* (L.) Small). Mat-grass.—Moist, open, sandy places on the Dougherty Plain, 14, 17, 18, infrequent.

**Verbena bonariensis* L. Vervain.—Roadsides and waste places, 9, 10, 14, 15, 17, infrequent.

V. bracteata Lag. & Rodr. (*V. bracteosa* Michx.).—Roadsides and waste places, 1, 7, rare.

**V. brasiliensis* Vellozo.—Waste places, 18, rare.

V. canadensis (L.) Britt. (*Glandularia canadensis* (L.) Small, *G. lambertii* (Sims) Small).—Rich, sandy, or rocky, open woods and roadsides, 5, 7, 9, 12, infrequent.

V. carnea Medic. (*Stylodon carolinensis* (Walt.) Small).—Dry, sandy open woods, pinelands, and barrens, frequent.

**V. litoralis* H. B. K.—Roadside in West Bainbridge, 17, rare.

**V. officinalis* L.—Roadsides and waste places, 9, 10, 11, 12, 13, infrequent.

**V. rigida* (L.) Spreng.—Roadsides and waste places, frequent.

V. scabra Vahl.—Moist woods and swampy places, 7, 9, rare.

**V. tenuisecta* Briq. (*Glandularia tenuisecta* (Briq.) Small).—Roadsides, pastures, waste places, and dry, open woods, abundant.

V. urticifolia L. White vervain.—Moist woods, thickets, and river banks, 5, 11, 17, 18, infrequent.

**Vitex agnus-castus* L. Chaste tree.—Rare escape, 17.

LABIATAE—Mint Family

Collinsonia canadensis L. Horsebalm.—Ravine slope near Fort Gaines, 11, rare.

Dicerandra linearifolia (Ell.) Benth.—Dry, sandy pinelands and oak barrens, frequent.

**Hyptis mutabilis* (A. Rich.) Briq.—River banks and waste places, 11, 12, 17, 18, infrequent.

H. radiata Willd.—Moist pinelands and marshy places, common.

**Lamium amplexicaule* L. Henbit.—Roadsides, waste places, and fields, common.

**Leonotis nepetaefolia* R. Br. Lion's ears.—Roadsides, barnyards, and waste places, common.

Lycopus rubellus Moench. Bugle weed, water-horhound.—Cypress ponds, wet pinelands, ditches, and low grounds generally, common.

L. virginicus L.—Wet or swampy woods, mostly in the Red Hills, 5, 11, 12, 18, infrequent.

**Mentha piperita* L. Peppermint.—Established only along Mill Creek just below Sheffield Mill, 12, rare.

**M. spicata* L. (*M. viridis* L.). Spearmint.—Reported from wet meadows, presumably near Americus along Muckalee Creek, 1 (Harper 1900).

Micheliella anisata (Sims) Briq. Citronella.—Rich woods, 1, 5, 11, 12, 17, infrequent.

Micromeria pilosiuscula (A. Gray) Small.—Wet margin of Spring Creek 5 miles above the power dam, 17, rare.

Monarda punctata L. subsp. *punctata*.—Dry, sandy soil of old fields, roadsides, bottomlands, and waste places, frequent.

**Perilla frutescens* (L.) Britt. Beefsteak plant.—Roadsides, river banks, waste places, barnyards, and open woods, frequent.

Physostegia virginiana (L.) Benth. (*Dracocephalum virginianum* L.). False-dragonhead.—Along streams and in moist, open woods, 12, 14, 17, rare.

Prunella vulgaris L. var. *lanceolata* (Bart.) Fern. Self-heal, heal-all.—Moist, sandy, grassy places, 8, 9, 12, 15, 17, infrequent.

Pycnanthemum flexuosum (Walt.) B.S.P. (*Koellia hyssopifolia* (Benth.) Britt.). Mountain mint.—Moist pinelands and moist, open, grassy places, frequent.

P. incanum (L.) Michx. (*Koellia incana* (L.) Kuntze, *P. puberulum* Grant & Epling).—Dry, open woods, common.

P. nudum Nutt. (*Koellia nuda* (Nutt.) Kuntze).—Moist pinelands, 7, 8, rare.

P. tenuifolium Schrad. (*Koellia flexuosa* of the *Manual*).—Moist, open woods and low grounds, 6, 9, 10, infrequent.

Salvia azurea Lam. subsp. *azurea*. Sage.—Dry, sandy, open woods and pinelands, frequent.

**S. coccinea* L. Scarlet sage.—Roadsides and waste places, 9, 13, 15, 17, infrequent.

S. lyrata L. Lyre-leaved sage.—Common in dry, open woods, and occasionally a weed on roadsides and in pastures.

S. urticifolia L.—Dry, open woods by the limestone quarry near Greer's Cave, 5, rare.

Satureja caroliniana (Michx.) Briq. (*Clinopodium georgianum* Harper) Basil.—Stream banks and bluffs and dry ravine crests, frequent.

Scutellaria altamaha Small (incl. subsp. *australis* Epling). Skullcap.—Open woods and thickets, 10, 12, 14, 17, infrequent.

S. elliptica Muhl. (*S. ovalifolia* Pers.).—Woods and thickets, frequent.

S. integrifolia L. (incl. *S. multiglandulosa* (Kearney) Small).—Pinelands, open woods, fields, and ditches, frequent.

S. parvula Michx. (incl. *S. australis* (Fassett) Epling).—Limestone outcrops and overburden by the quarry near Greer's Cave, 5, rare.

Teucrium canadense L. (incl. *T. nashii* Kearney). Germander.—Moist, open places, 17, 18, rare.

Trichostema dichotomum L.—Dry, sandy barrens, pinelands, open woods, and fields, common.

T. setaceum Houtt. (*T. lineare* Walt.).—Dry, sandy soil of roadsides, fields, and open woods, 9, 10, 11, 12, infrequent.

SOLANACEAE—Nightshade Family

**Datura stramonium* L. (incl. *D. tatula* L.). Jimson-weed, thorn-apple.—Barnyards, country roadsides, and waste places, frequent.

(**Lycopersicon esculentum* Mill. (*L. lycopersicon* (L.) Karst.). Tomato.—Rarely spontaneous in dumps and waste places.)

(**Nierembergia frutescens* Dur. Cup flower.—Escaped on roadside near Blakely, 12).

**Petunia violacea* Lindl. Petunia.—Roadsides and waste places, frequent.

**Physalis angulata* L. Ground-cherry.—Roadsides, waste places, and river banks, frequent.

P. barbadensis Jacq.—Roadsides, river banks, and waste places, 10, 12, 13, 14, 18, infrequent. Perhaps introduced from tropical America.

- P. heterophylla* Nees. (incl. *P. ciliosa* Rydb.).—Open, sandy places, 10, 17, rare.
P. maritima M. A. Curtis (*P. viscosa* of the *Manual*, not L.).—Dry, sandy barrens, 9, 14, rare.
P. pubescens L.—Along the Chattahoochee and Flint rivers, 9, 12, infrequent.
P. virginiana Mill. (incl. *P. intermedia* Rydb.).—Dry, sandy soil, 1, 14, rare.
Solanum carolinense L. Horse-nettle.—Roadsides, river banks, sandy thickets, and waste places, common.
S. nigrum L. (incl. *S. gracile* Link). Nightshade.—Waste places, roadsides, and margins of ponds and streams, frequent.
**S. pseudo-capsicum* L. Jerusalem-cherry.—Established on the Simmons Farm 6 miles northwest of Blakely, 12, rare.
**S. torreyi* A. Gray (*S. perplexum* Small).—Roadsides and sandy fields, 9, 11, 12, infrequent.

SCROPHULARIACEAE—Figwort Family

- Aureolaria flava* (L.) Farwell subsp. *reticulata* (Raf.) Pennell. Yellow foxglove.—Open woods of stream banks, ravines, and swamp margins, 1, 12, 13, 14, 15, infrequent.
A. pectinata (Nutt.) Pennell subsp. *pectinata*.—Dry oak woods and sandy barrens, 1, 9, 12, 14, 15, 17, infrequent.
A. virginica (L.) Pennell.—Dry, open woods, often on ravine slopes and along streams, frequent.
Bacopa caroliniana (Walt.) Robins. (*Hydrotrida caroliniana* (Walt.) Small).—Shallow water of ponds, ditches, borrow-pits, sloughs, and sluggish streams, common.
Buchnera floridana Gandoger. Blueheart.—Moist pinelands, frequent.
Chelone glabra L. (incl. subsp. *typica* Pennell). Turtle-head.—Springy place along ravine near Gilbert's Landing, 12, rare.
C. obliqua L. subsp. *obliqua*.—Vicinity of Cuthbert, 5 (Pennell 1935), rare.
Gerardia fasciculata Ell. subsp. *fasciculata* (*Agalinis fasciculata* (Ell.) Raf.). False-foxglove.—Old fields and roadsides, common.
G. harperi (Pennell) Pennell (*Agalinis harperi* Pennell).—Moist pinelands, 10, 14, rare.
G. linifolia Nutt. (*Agalinis linifolia* (Nutt.) Britt.).—Wet pinelands and margins of cypress ponds, 1, 7, 14, rare.
G. obtusifolia (Raf.) Pennell (*Agalinis erecta* (Walt.) Pennell).—Moist or dry pinelands and moist meadows, 1, 10, 14, 18, infrequent.
G. plukenetii Ell. (*Agalinis plukenetii* (Ell.) Raf.).—Dry, open oak-pine woods and pinelands, 1, 5, 14, rare.
G. purpurea L. (*Agalinis purpurea* (L.) Pennell).—Moist, sandy soil, 1 (Pennell 1929), rare.
G. tenella (Pennell) Pennell (*Agalinis tenella* Pennell).—Dry, sandy soil, 1 (Pennell 1929), rare.
G. tenuifolia Vahl (*Ayalinis tenuifolia* (Vahl) Raf.).—Dry, open woods, pinelands, old fields, meadows, and roadsides, frequent.
Gratiola brevifolia Raf.—Wet pinelands, 7, 14, 15, infrequent.
G. floridana Nutt.—Swampy woods, mostly in the Red Hills, 2, 5, 10, 12, infrequent.
G. pilosa Michx. (*Tragiola pilosa* (Michx.) Small & Pennell).—Moist, or occasionally dry, pinelands and bogs, common.
G. ramosa Walt.—Moist pinelands, frequent.
G. virginiana L. (*G. sphaerocarpa* Ell.).—Wet woods and wet margins of ponds and streams, common.
Linaria canadensis (L.) Dum. Blue toadflax.—Sandy soil of fields, open woods, pecan groves, and oak barrens, common.
L. texana Scheele (*L. canadensis texana* (Scheele) Pennell).—Sandy soil of fields, roadsides, waste places, and barrens, frequently in association with *L. canadensis*, common.
Lindernia anagallidea (Michx.) Pennell (*Ilysanthes inaequalis* (Walt.) Pennell). False-pimpernel.—Moist sand of pond and stream margins, ditches, borrow-pits, and moist pinelands, frequent.
L. dubia (L.) Pennell (*Ilysanthes dubia* (L.) Barnh.).—Wet, sandy or muddy margins of ponds and streams, ditches and borrow-pits, frequent.
L. monticola Nutt. (*Ilysanthes monticola* (Nutt.) Raf.).—Moist pinelands, 1, 7, 10, 17, infrequent.

Macranthera flammea (Bartr.) Pennell. Candles.—Wet, sandy thickets along branches and in bogs, 8, 12, rare.

Mecardonia acuminata (Walt.) Small.—Wet margins of ponds and streams and moist pinelands, common.

Micranthemum umbrosum (Walt.) Blake (*Globifera umbrosa* (Walt.) J. F. Gmel.).—Shallow water and wet margins of ponds and streams, common.

Mimulus alatus Ait. Monkey flower.—Moist or swampy, alluvial woods along streams, mostly in the Red Hills, 2, 5, 11, 18, infrequent.

**Paulownia tomentosa* (Thunb.) Steud. Princess tree.—Reported from 11, 14 (Duncan 1950), but not seen out of cultivation by the writer.

Pedicularis canadensis L. Wood betony.—Dry, open woods, mostly in the Red Hills, frequent.

Penstemon australis Small. Beard tongue.—Sandy soil of pinelands, oak woods, and barrens, common.

P. laevigatus Solander (*P. penstemon* (L.) MacM.).—Banks of the Chattahoochee River and open, sandy woods on the Dougherty Plain, 9, 12, 14, infrequent.

P. multiflorus Chapm.—Dry, sandy pinelands near the outlet of Cane Water Pond, 17, rare.

Schwalbea americana L. (incl. *S. australis* Pennell). Chaffseed.—Moist, open pinelands, 12, 13, rare.

**Scoparia dulcis* L. Goatweed.—Sandy soil of roadsides and waste places, 12, 13, 15, 17, infrequent; apparently introduced from tropical America.

Scrophularia marilandica L. Figwort.—Bank of the Chattahoochee River near Neal's Landing bridge, 18, rare.

Seymeria cassioides (Walt.) Blake (*Afzelia cassioides* (Walt.) J. F. Gmel.).—Moist pinelands, 10, 12, 13, 14, 17, infrequent.

S. pectinata (Pursh) Kuntze subsp. *pectinata* (*Afzelia pectinata* (Pursh) Kuntze).—Dry, sandy soils of oak-pine woods and pinelands, 1, 5, 7, 11, 12, 17, 18, infrequent.

**Verbascum thapsus* L. Mullein.—Roadsides, old fields, and waste places, frequent.

**Veronica arvensis* L. Corn Speedwell.—Roadsides and waste places, 2, 7, 9, 12, 17, infrequent.

V. peregrina L. Neckweed.—Roadsides, waste places, and fields, frequent.

BIGNONIACEAE—Bignonia Family

Bignonia capreolata L. (*Anisostichus crucigera* (L.) Bureau). Cross vine.—Hammocks, swamps, ravines, bluffs, and stream banks, abundant.

Campsis radicans (L.) Seeman (*Bignonia radicans* L.). Trumpet creeper, cow itch.—Abundant vine of stream banks and bottoms, borders of woods and swamps, and fence-rows, and frequently a weed in old fields and along roadsides.

Catalpa bignonioides Walt. (*C. catalpa* (L.) Karst.). Catalpa, Indian bean.—Stream banks, common.

OROBANCHACEAE—Broom-rape Family

Conopholis americana (L.) Wallr. Squaw root, cancer root.—Rich woods of ravines, bluffs, and stream banks, parasitic usually on oaks, frequent.

Epifagus virginiana (L.) Bart. (*Leptammium virginianum* (L.) Raf.). Beech drops.—Frequent parasite on roots of the beech tree, mostly in the Red Hills in ravines and on bluffs; rare on the Dougherty Plain in hammocks.

Orobanche uniflora L. (*Thalesia uniflora* (L.) Britt.). Broom rape.—Rich woods of ravine northwest of Cuthbert, 5, rare.

LENTIBULARIACEAE—Bladderwort Family

Pinguicula caerulea Walt. Butterwort.—Boggy swamps and moist pinelands, 7, 12, rare.

P. lutea Walt. Yellow butterwort.—Moist pinelands and bogs, frequent.

Utricularia biflora Lam. (*U. pumila* Walt.). Bladderwort.—Shallow water of ponds and bogs, 1, 6, 7, 10, 12, 14, 17, infrequent.

U. cornuta Michx. (*Stomolisia cornuta* (Michx.) Raf.). Helmit flower.—Moist pinelands and shallow, open margins of grassy, limesink ponds, 1, 9, 10, 12, 14, 17, infrequent.

U. fibrosa Walt.—Shallow water of wet pinelands, cypress ponds, and borrow-pits, 10, 12, infrequent.

U. foliosa L.—Shallow water of ponds, 7, 12, 17, 18, infrequent.

U. gibba L.—Shallow water of small pond in pinelands near Pretoria, 9, rare.

U. inflata Walt. (incl. *U. radiata* Small).—Shallow water of ponds, borrow-pits, ditches, wet pinelands, sloughs, and sluggish streams, common.

U. juncea Vahl (*Stomosis juncea* (Vahl) Barnh.).—Wet pinelands and shallow margins of ponds, 1, 13, rare.

U. purpurea Walt. (*Vesicula purpurea* (Walt.) Raf.).—Shallow water of ponds, frequent.

U. resupinata B. D. Greene (*Lecticula resupinata* (B. D. Greene) Barnh.).—Shallow water of pineland ponds, 13, 18, rare.

U. subulata L. (incl. *Setiscapella subulata* (L.) Barnh., *S. cleistogama* (A. Gray) Barnh.).—Wet sand of moist pinelands, bogs, seepage slopes, and wet meadows, frequent.

ACANTHACEAE—Acanthus Family

Diplotera brachiata (Pursh) Spreng. (*Diapedium brachiatum* (Pursh) Kuntze).—Alluvial wooded bottoms along the Chattahoochee River, 12, 18, infrequent.

D. halei Ridd. (*Yeatsea viridiflora* (Nees) Small).—Moist, alluvial woods of bottoms and banks of streams on the Dougherty Plain, frequent.

Dyschoriste oblongifolia (Michx.) Kuntze.—Sandy soil of pinelands, oak woods, barrens, and thickets, common.

Elytraria virgata Michx. (*Tubiflora carolinensis* (Walt.) J. F. Gmel.).—Moist, alluvial or sandy woods along the Flint River and its tributaries, frequent.

Hygrophila lacustris (Schlecht.) Nees.—Shallow water of Fourmile Creek south of Bainbridge, 17, rare.

Justicia americana (L.) Vahl (*Dianthera americana* L.). Water-willow.—Rocky shoal in Flint River above junction with Ichawaynochaway Creek, 14, rare.

J. ovata (Walt.) Lindau (incl. *J. lanceolata* (Chapm.) Small).—Shallow water and wet margins of ponds, streams, and swamps, common.

Ruellia carolinensis (Walt.) Steud. (*R. parviflora* sensu Britt.).—Sandy soil of open woods, thickets, and roadbanks, common.

R. ciliosa Pursh (incl. *R. humilis* of the *Manual*).—Dry, sandy soil, 12, 14, rare.

PHRYMACEAE—Lopseed Family

Phryma leptostachya L. Lopseed.—Rich woods in the Red Hills, 5, 11, 12, rare.

PLANTAGINACEAE—Plantain Family

**Plantago aristata* Michx. Long-bracted plantain.—Dry roadsides and waste places, frequent.

P. heterophylla Nutt.—Sandy roadsides, fields, and waste places, frequent.

**P. lanceolata* L. English plantain, rib-grass, buckhorn.—Waste places, especially along railroads in towns, 1, 5, 9, 11, 15, 17, infrequent.

**P. major* L. Common plantain.—Rare weed, 1, 12.

P. sparsiflora Michx.—Moist, grassy pinelands, 7, 10, rare.

P. virginica L.—Roadsides, sandy fields, and waste places, common.

RUBIACEAE—Madder Family

Borreria laevis (Lam.) Griseb.—Alluvial bottoms along the Flint River and wooded ravine slopes, 14, 17, rare.

Cephalanthus occidentalis L. Buttonbush.—Ponds, sloughs, swamps, and stream margins, abundant.

Diodia teres Walt. (*Diodella teres* (Walt.) Small). Buttonweed.—Dry, sandy, open places, especially roadsides, old fields, and barrens, common.

D. virginiana L. (incl. *D. tetragona* Walt., *D. hirsuta* Pursh, *D. harperi* Small).—Wet places, especially pond and stream margins, moist pinelands, and ditches, common.

Galium aparine L. Goose-grass, cleavers.—Roadsides, waste places, and moist woods, 9, 11, 12, 18, infrequent.

G. circaeans Michx. Wild-licorice.—Rich woods, 5, 11, 12, 13, 16, 17, infrequent.

- G. hispidulum* Michx. (*G. bermudense* of the *Manual*).—Dry, often sandy, open woods, frequent.
- G. obtusum* Bigel. (incl. *G. tinctorium* of the *Manual*, *G. filifolium* (Wieg.) Small).—Swampy or marshy places, 2, 7, 10, 14, infrequent.
- G. pilosum* Ait.—Dry, sandy, open woods and pinelands, common.
- G. triflorum* Michx. Sweet-scented bedstraw.—Rich or rocky woods, 7, 12, rare.
- G. uniflorum* Michx.—Rich woods, frequent.
- Hedyotis boscii* DC. (*Oldenlandia boscii* (DC.) Chapm.).—Moist, sandy margins of ponds, streams, and ditches, 7, 9, 13, 14, 18.
- H. uniflora* (L.) Lam. (*Oldenlandia uniflora* L.).—Moist pinelands and bogs, 1, 10, 12, 13, 14, 17, infrequent.
- Houstonia longifolia* Gaertn.—Sandy, open places along Kinchafoonee Creek, 6, 7, rare.
- H. nigricans* (Lam.) Fern. (*H. angustifolia* Michx.).—Dry, open places on limestone, 5, 17, rare.
- H. patens* Ell. (*H. pusilla* of the *Manual*).—Sandy, open places, 1, 5, 7, 11, 12, 14, 17, infrequent.
- H. procumbens* (Walt.) Standley.—Sandy soil of pinelands and open oak woods, common.
- H. purpurea* L.—Banks and bluffs of the Chattahoochee River and rich woods of ravines in the Red Hills, 5, 11, 12, infrequent.
- Mitchella repens* L. Partridge berry.—Hammocks, ravines, and bluffs, usually in association with *Smilax pumila* Walt., common.
- Pinckneya pubens* Michx. Fever tree.—Sandy swamps, 1, 6, 10, 17, infrequent.
- **Richardia scabra* L. Florida-pusley, Mexican-clover.—Sandy fields, roadsides, and waste places, common.
- Spermacoce glabra* Michx.—Alluvial, wooded bottoms along the Flint River, 14, 15, 17, infrequent.

CAPRIFOLIACEAE—Honeysuckle Family

- **Lonicera japonica* Thunb. (*Nintooa japonica* (Thunb.) Sweet). Japanese honeysuckle.—Common weedy vine of roadsides, fence-rows, thickets, old homesites, and open woods.
- L. sempervirens* L. (*Phenianthus sempervirens* (L.) Raf.). Coral honeysuckle, woodbine.—Hammocks, ravines, bluffs, and stream banks, common.
- Sambucus canadensis* L. Elder.—Swamps, bottoms, and wet ravines, common.
- Viburnum acerifolium* L. Maple-leaved arrowwood.—Dry, loamy woods of ravine slopes and crests, 11, 12, infrequent.
- V. dentatum* L. (incl. *V. semitomentosum* (Michx.) Rehder).—Woods along streams, in ravines, and in moist hammocks, common.
- V. nudum* L. (incl. *V. nitidum* Ait.). Possum haw.—Sandy swamps, bogs, and seepage slopes, common.
- V. obovatum* Walt.—Moist hammocks and woods bordering streams and ponds on the Dougherty Plain, very common.
- V. rufidulum* Raf. Southern black haw.—Dry woods, hammocks, ravines, bluffs, and stream banks, common.

VALERIANACEAE—Valerian Family

- Valerianella radiata* (L.) DuRoi.—Moist, open grounds and waste places near the Chattahoochee River, 4, 11, 12, infrequent.

CUCURBITACEAE—Gourd Family

- Cayaponia boykinii* (Torr. & Gray) Cogn.—Moist bottom woods along the Chattahoochee River at Butler's Landing, 18, rare.
- **Citrullus vulgaris* Schrad. (*C. citrullus* (L.) Small). Watermelon.—Frequently spontaneous on roadsides and in waste places.
- **Lagenaria siceraria* (Molina) Standl. (*Cucurbita lagenaria* L.). Gourd.—Roadsides and waste places, 12, 13, infrequent.
- Melothria pendula* L. Melonette.—Moist woods along streams or around ponds, 7, 11, 14, 17, infrequent.

CAMPANULACEAE—Bellflower Family

Campanula americana L. (*Campanulastrum americanum* (L.) Small). Bellflower.—Rich, calcareous woods along Fowltown Creek, 7, rare.

Lobelia amoena Michx. var. *amoena*.—Wooded slopes of ravines and bluffs in the Red Hills, 11, 12, rare.

L. amoena Michx. var. *glandulifera* A. Gray (*L. glandulifera* of the *Manual*).—Swamps and moist woods, mostly on the Dougherty Plain, 5, 9, 10, 12, 13, 15, 17, infrequent.

L. boykinii Torr. & Gray.—Shallow cypress ponds and wet pinelands, frequent.

L. cardinalis L. subsp. *cardinalis*.—Swamps and wet woods along streams, frequent.

L. flaccidifolia Small (incl. *L. halei* Small).—Stream and pond margins, 10, rare.

L. glandulosa Walt.—Moist pinelands, bogs, and wet meadows, frequent.

L. nuttallii Roem. & Schult.—Sandy pinelands, 1, 15, rare.

L. puberula Michx.—Low grounds along streams and roadside ditches, moist pinelands, and wooded slopes, common.

Triodanis biflora (R. & P.) Greene (*Specularia biflora* (R. & P.) F. & M.). Venus's looking-glass.—Roadsides, waste places, and fields, often in association with *T. perfoliata*, frequent.

T. perfoliata (L.) Nieuwl. (*Specularia perfoliata* (L.) A. DC.).—Roadsides, waste places, and fields, frequent.

**Wahlenbergia marginata* (Thunb.) A. DC.—Roadsides and old fields, 9, 11, infrequent.

COMPOSITAE—Composite Family

**Acanthospermum australe* (Loefl.) Kuntze. Paraguay bur.—Sandy roadsides, frequent.

**A. hispidum* DC.—Sandy roadsides, 12, 14, 15, 17, infrequent.

**Achillea millefolium* L. Yarrow, milfoil.—Roadsides, old fields, and dry, open places, 2, 9, 11, 12, 15, 17, infrequent.

Actinomeris alternifolia (L.) DC. (*Ridan alternifolia* (L.) Britt.). Wing-stem.—Rich woods, 5, 11, 12, 17, infrequent.

Ambrosia artemisiifolia L. (incl. *A. monophylla* (Walt.) Rydb., *A. glandulosa* Scheele, *A. clatior* L., *A. rugelii* Rydb.). Common ragweed.—Roadsides, old fields, waste places, and river banks, common.

A. trifida L. Giant ragweed.—Alluvial bottomlands and waste places, 11, 18, rare.

Antennaria plantaginifolia (L.) Hook. Pussy's-toes.—Dry slopes and dry, open woods, mostly in the Red Hills, 5, 10, infrequent.

A. solitaria Rydb.—Rich, shady woods near Cuthbert, 5, rare.

**Anthemis cotula* L. (*Maruta cotula* (L.) DC.). Mayweed, chamomile, dog-fennel.—Roadsides and waste places, frequent.

Artemisia caudata Michx. Wormwood.—Dry limestone outcrop by quarry near Greer's Cave, 5, rare.

Aster adnatus Nutt. Aster.—Dry or slightly moist pinelands and dry oak woods on the Dougherty Plain, common.

A. concolor L.—Dry, sandy pinelands, oak woods, and barrens, frequent.

A. dumosus L. (incl. *A. coridifolius* Michx.).—Moist margins of streams and ponds, pinelands, open woods, thickets, and edges of fields, frequent.

A. eryngiifolius Torr. & Gray.—Moist, boggy pinelands near Recovery, 17, rare.

A. lateriflorus (L.) Britt.—Woods or thickets, especially along streams, frequent. A possible hybrid between this species and *A. dumosus* L. was collected along Aycocks Creek, 6 miles northwest of Colquitt, 13.

A. linariifolius L. (*Ionactis linariifolius* (L.) Greene).—Dry pinelands, oak woods, and barrens, 8, 10, 14, 15, 18, infrequent.

A. novi-belgii L.—Swamp along Kioksee Creek west of Pretoria, 9, rare.

A. paludosus Ait. subsp. *hemisphaericus* (Alex.) Cronquist (*A. hemisphaericus* Alex.).—Open ground near Kinchafoonee Creek northeast of Bronwood, 6, rare.

A. patens Ait.—Dry, open places in the Red Hills, 5, 11, 12, rare.

A. paternus Cronquist (*Seriocarpus asteroides* (L.) B. S. P.).—Dry, open woods, 5, 9, 11, infrequent.

A. pilosus Willd. (incl. var. *platyphyllus* T. & G., *A. ramosissimus* of the *Manual*).—Dry, open places, especially roadsides, old fields, and vacant lots, frequent.

A. reticulatus Pursh (*Doellingeria reticulata* (Pursh) Greene).—Moist, sandy soil of boggy areas just south of the escarpment, 17, rare.

A. sagittifolius Wed.—Dry woods, especially on river banks, bluffs, and ravine slopes, frequent.

A. sericocarpoides (Small) K. Schum (*Doellingeria humilis* (Willd.) Britt.).—Thickety border of boggy swamp 2 miles south of Hilton, 12, rare.

A. shortii Lindl. (incl. *A. campsiorus* Small).—Rich woods of ravine tributary to Hog Creek several miles west of Coleman, 11, rare.

A. simplex Willd. (*A. lamarkianus* Nees.).—Low grounds and banks of streams, 10, 12, 15, infrequent.

A. tortifolius Michx. (*Sericocarpus bifolius* (Walt.) Porter). White-topped aster.—Dry pinelands, oak woods, and sandy barrens, common.

A. undulatus L.—Dry woods, 10, 11, 12, 14, infrequent. Possible hybrids between this species and *A. sagittifolius* Wed. were collected in 12, 14, and between this species and *A. pilosus* Willd. from a ravine crest near Fort Gaines, 11.

A. vimineus Lam.—Along streams, 12, 14, rare.

A. walteri Alex.—Dry, rolling pineland near the escarpment, 8, 15, rare.

Baccharis glomeruliflora Pers. Groundsel tree, silverling.—Rare; collected only in 13.

B. halimifolia L.—Swamps, thickets, and low grounds in general, very common.

Balduina uniflora Nutt. (*Endorima uniflora* (Nutt.) Barnh.).—Moist pinelands, frequent.

Berlandiera pumila (Michx.) Nutt. Greeneyes.—Dry, sandy pinelands, oak woods, and barrens in the outer part of the Dougherty Plain, frequent.

Bidens bipinnata L. Spanish needles.—River banks and bottoms, old fields, and waste places, common.

B. discoidea (T. & G.) Britt.—On floating logs and old stumps in cypress ponds, 12, 13, 14, 18, infrequent.

B. frondosa L. Beggar-ticks, stick-tight.—River banks and bottoms, marshy places, and woods, 9, 11, 12, 14, infrequent.

Bigelovia nudata (Michx.) DC. (*Chondrophora nudata* (Michx.) Britt.).—Moist pinelands and shallow margins of pineland ponds, common.

Boltonia diffusa Ell.—Moist pinelands and low grounds, frequent.

Brickellia cordifolia Ell. (*Coleosanthus cordifolius* (Ell.) Kuntze).—Rich, dry woods in the Red Hills, 5, 12, infrequent.

Brintonia discoidea (Ell.) Greene.—Dry woods near the Chattahoochee River and along the escarpment, 11, 12, 17, 18, infrequent.

Cacalia atriplicifolia L. (*Mesadenia atriplicifolia* (L.) Raf.). Indian-plantain.—Dry or rocky woods, 5, 12, rare.

C. diversifolia T. & G. (*Mesadenia diversifolia* (T. & G.) Greene).—Swamps along streams on the Dougherty Plain, 12, 13, infrequent.

C. lanceolata Nutt. (*Mesadenia lanceolata* (Nutt.) Raf.).—Moist pinelands, 8, 9, 10, infrequent.

C. maxima (Harper), comb. nov., fundata super *Mesadenia maxima* Harper, in Small, Fl. S. E. U. S. 1301, 1903.—Apparently known only from the type locality, dry pine barrens south of Leslie, 1 (Harper 1901).

C. ovata Walt. (*Mesadenia Elliottii* Harper).—Swamps, wet woods, and stream margins on the Dougherty Plain, 6, 7, 8, 10, 12, 13, 14, infrequent.

C. sulcata Fern. (*Mesadenia sulcata* (Fern.) Small).—Bogs and wet or moist woods, 1, 5, 7, 11, 12, infrequent. The type locality is a swamp near Smithville, 7.

Carphephorus pseudo-liatris Cass.—Moist, boggy pinelands 1 mile east of Recovery, 17, rare.

**Centaurea cyanus* L. Bachelor's button, cornflower.—Roadsides, 1, 9, 14, infrequent. *Chaptalia tomentosa* Vent. Sunbonnet.—Wet sand of moist pinelands and boggy areas, frequent.

Chrysogonum virginianum L. (incl. *C. australe* Alex.).—Dry woods, 5, 12, 13, 17, infrequent.

Chrysopsis gossypina (Michx.) Nutt. (*C. pilosa* (Walt.) Britt.). Golden-aster.—Dry, sandy soils of pinelands, oak woods, and barrens in the outer part of the Dougherty Plain, frequent.

C. graminifolia (Michx.) Ell. (*Pityopsis aspera* (Shuttlw.) Small, not *P. graminifolia* of the *Manual*).—Dry, sandy soils of pinelands, oak woods, and oak barrens, common.

- C. mariana* (L.) Nutt.—Dry, open woods, common.
- C. nervosa* (Willd.) Fern. (*Pityopsis graminifolia* of the *Manual*).—Dry, sandy soils of pinelands, oak-pine woods, and oak barrens, common.
- C. oligantha* Chapm. (*Pityopsis oligantha* (Chapm.) Small).—Sandy pinelands on the Dougherty Plain, 12, 13, rare.
- C. trichophylla* Nutt.—Dry sand along Kirkland Creek near Saffold, 12, rare.
- **Cichorium intybus* L. Chicory.—Railroad yards in Leary, 10, rare.
- Cirsium altissimum* (L.) Spreng. Tall thistle.—Dry woods and open places, 5, 7, 9, 11, 12, 14, infrequent.
- C. horridulum* Michx. (incl. *C. smallii* Britt.). Yellow thistle.—Dry woods, pinelands, and roadsides, common.
- C. lecontei* T. & G.—Moist pinelands 2 miles east of Cordrays Mill, 10, rare.
- C. virginianum* (L.) Michx. (incl. *C. revolutum* Small).—Moist pinelands, 7, 8, rare.
- C. sp.*—Swampy woods and moist pinelands, 7, 10, 12, rare. The writers material of this thistle has been referred to both *C. nuttallii* (DC.) A. Gray and *C. muticum* Michx. Although it seems more closely related to the latter, it has small heads and subglabrous involucre and may be an undescribed variety or species.
- **Cnicus benedictus* L. Blessed-thistle.—Fields and waste places, 1, 14, rare.
- **Conyza ambigua* DC. (*Leptilon linifolium* (Willd.) Small).—Rare weed in towns, 9, 17.
- C. canadensis* (L.) Cronquist (incl. *Leptilon pusillum* (Nutt.) Britt., *L. canadense* (L.) Britt.).—Roadsides, stream banks, waste places, and fields, common. The variety with nearly glabrous stems and purple-tipped bracts, var. *pusilla* (Nutt.) Cronquist (*Erigeron pusillus* Nutt.), is more common in southwestern Georgia than the typical variety.
- Coreopsis auriculata* L.—Dry, rich woods on ravine slopes near Fort Gaines, 11, rare.
- **C. basalis* (Dietr.) Blake (*C. drummondii* (D. Don) T. & G.).—Roadsides and waste places, 9, 11, 13, 17, 18, infrequent.
- C. delphinifolia* Lam.—Low grounds along streams and in pinelands, 1, 6, 8, rare.
- C. gladiata* Walt. (incl. *C. angustifolia* Ait., *C. linifolia* Nutt., *C. longifolia* Small, *C. integrifolia* Poir., *C. helianthoides* Beadle).—Moist pinelands and sandy bogs, 1, 8, 10, 17, infrequent.
- C. lanceolata* L. (incl. *C. crassifolia* Ait.).—Dry, sandy pinelands and oak woods, common, also occasional in waste places as an escape from cultivation.
- C. major* Walt.—Dry woods, frequent.
- C. nudata* Nutt.—Shallow cypress ponds and wet pinelands, frequent.
- C. pubescens* Ell.—Near Ichawaynochaway Creek west of Leary, 10, rare.
- **C. tinctoria* Nutt.—Roadsides and waste places, 9, 10, 15, infrequent.
- C. tripteris* L.—Along streams, and in open woods, thickets, and old fields, 1, 5, 6, 8, 9, 12, infrequent.
- **Cosmos bipinnatus* Cav.—Roadsides, 5, 10, 11, 12, infrequent.
- **C. sulphureus* Cav.—Roadsides and waste places, 9, 10, 13, 14, infrequent.
- Echinacea purpurea* (L.) Moench. Purple cone flower.—Dry, calcareous woods near Greer's Cave and the adjacent limestone quarry, 5, rare.
- Eclipta alba* (L.) Hassk.—Pond and stream margins and low, waste grounds, frequent.
- Elephantopus carolinianus* Willd. Elephant foot.—Woods and thickets, especially in alluvial soils, common.
- E. elatus* Bertol.—Dry, sandy pinelands and open woods, 8, 9, 10, 15, 18, infrequent.
- E. nudatus* A. Gray.—Moist, acid woods and sandy swamps, 5, 12, rare.
- E. tomentosus* L.—Dry woods and dry pinelands, very common.
- Erechtites hieracifolia* (L.) Raf. Fireweed.—Disturbed habitats, especially river banks, waste places, roadsides, and cut-over woods, common.
- Erigeron philadelphicus* L. Fleabane.—Roadsides and open, grassy slopes, 10, 11, 17, rare.
- E. pulchellus* Michx. Robin's-plantain.—Dry, open woods near Greer's Cave, 5, rare.
- E. strigosus* Muhl. (*E. ramosus* (Walt.) B. S. P.). Daisy fleabane.—Roadsides, old fields, dry open woods, very common.
- E. vernus* (L.) T. & G.—Shallow cypress ponds and wet pinelands, common.
- Eupatorium album* L.—Dry, sandy pinelands and open woods, common.
- E. aromaticum* L. Wild-hoarhound.—Dry, sandy pinelands and open woods, common.

- E. capillifolium* (Lam.) Small. Dog-fennel.—Old fields, pastures, and roadsides, common.
- E. coelestinum* L. (*Conoclinium coelestinum* (L.) DC.). Mistflower.—Stream margins and thickets, common.
- E. compositifolium* Walt. Dog-fennel.—Sandy old fields, roadsides, and dry pinelands, very common.
- E. cuneifolium* Willd.—Dry pinelands and oak barrens, 7, 14, 17, rare.
- E. fistulosum* Barratt (*E. maculatum* of the *Manual*). Joe-Pye-weed.—Sandy swamps and marshy places, especially along streams, frequent.
- E. hyssopifolium* L. (incl. *E. lecheaefolium* Greene, *E. torreyanum* Short).—Sandy pinelands, dry, open woods, and moist meadows, common.
- E. incarnatum* Walt.—Rich, dry or rocky woods, chiefly in the watershed of the Chattahoochee River, 5, 7, 11, 12, 18, infrequent.
- E. leptophyllum* DC.—Wet, grassy margins of shallow ponds, 9, 14, infrequent.
- E. perfoliatum* L. Boneset.—Low grounds and moist, sandy thickets, mostly along streams, frequent.
- E. pilosum* Walt. (*E. verbenaeifolium* Michx.).—Sandy bogs and moist pinelands, 5, 12, 13, rare.
- E. pinnatifidum* Ell.—Thickets on margin of sandy bog 2 miles south of Hilton, 12, rare.
- E. purpureum* L. (*E. trifoliatum* but not *E. purpureum* of the *Manual*). Joe-Pye-weed.—Rich woods, 5, 11, 13, rare.
- E. recurvans* Small.—Moist pinelands, frequent.
- E. rotundifolium* L. (incl. *E. pubescens* Muhl.). False-hoarhound.—Sandy pinelands and bogs, common.
- E. rugosum* Houtt. (*E. urticaefolium* Reichard). White snakeroot.—Bluffs, banks, and bottom woods along the Chattahoochee River, 11, 12, 18, rare.
- E. scabridum* Ell.—Low ground of Miller Slough eight miles west of Albany, 9, rare.
- E. semiserratum* DC.—Wet, sandy places, especially stream and pond margins and moist pinelands, common.
- E. serotinum* Michx.—River banks and low grounds, frequent.
- E. torifolium* Chapm.—Dry, sandy woods, pinelands, and barrens, common.
- **Facelis retusa* (Lam.) Sch. Bip. (*F. apiculata* Cass.).—Dry roadsides and waste places, common.
- Gaillardia lanceolata* Michx. Blanket flower, bandana-daisy.—Dry woods, pinelands, and sandy barrens, frequent.
- **G. pulchella* Foug.—Roadsides and waste places, 6, 9, 10, 13, 14, infrequent.
- Gnaphalium falcatum* Lam.—Roadsides, waste places, and fields, common.
- G. obtusifolium* L. Rabbit-tobacco.—Old fields and sandy open places in general, common.
- **G. peregrinum* Fern. (*G. spathulatum* Lam., not Burm. f.).—Sandy fields, roadsides, and waste places, common.
- G. purpureum* L.—Roadsides, waste places, and sandy fields, 11, 12, 14, 17, infrequent.
- Haplopappus divaricatus* (Nutt.) A. Gray (*Isopappus divaricatus* (Nutt.) T. & G.).—Sandy old fields and roadsides, common.
- Helenium autumnale* L. (incl. *H. latifolium* Mill., *H. parviflorum* Nutt.). Sneezeweed.—Low grounds, mainly along streams, frequent.
- H. nudiflorum* Nutt. Purplehead sneezeweed.—Low grounds, 10, 15, rare.
- H. nuttallii* A. Gray (*H. helenium* (Nutt.) Small).—Shallow cypress ponds and wet pinelands, frequent.
- H. tenuifolium* Nutt. Bitterweed.—Roadsides, pastures, old fields, weedy lawns, and waste places, abundant. This species and *Verbena tenuisecta* Briq., with which it is usually associated, are the two most conspicuous roadside weeds in summer and autumn.
- Helianthus angustifolius* L. Sunflower.—Moist, sandy, open grounds, moist pinelands, and margins of swamps and bogs, common.
- **H. annuus* L. Common sunflower.—Waste places, 6, 9, 13, 14, frequent.
- **H. debilis* Nutt. var. *cucumerifolius* (T. & G.) A. Gray (*H. cucumerifolius* T. & G.).—Waste places and roadsides, frequent.
- H. divaricatus* L.—Dry, open woods, 1, 5, 10, 12, 18, infrequent.
- H. floridanus* A. Gray.—Bogs and springy slopes, 11, 12, rare. This species, or at least the writer's material should perhaps be treated as a variant of *H. angustifolius* L.

H. microcephalus T. & G.—Wooded slopes of ravines and bluffs and woods or thickets along streams, 5, 6, 11, 14, 17, infrequent.

H. radula (Pursh) T. & G.—Sandy pinelands, oak woods, and barrens, frequent.

H. strumosus L.—Dry woods and pinelands, 7, 8, 9, infrequent.

H. tomentosus Michx.—Wooded slopes of ravines and bluffs, stream banks and bottoms, 5, 11, 12, 17, infrequent.

Heliopsis minor (Hook.) C. Mohr.—Open woods, 7, 11, 12, 17, infrequent.

Heierotheca subaxillaris (Lam.) Britt. & Rusby. Camphorweed.—Roadsides and waste places, very common.

Hieracium gronovii L. (incl. var. *foliosum* Michx.).—Dry woods and pinelands, common.

H. venosum L. Rattlesnake weed, Poor Robin's-plantain.—Dry, open woods on ravine slopes, 3, 5, rare.

Hymenopappus scabiosaeus L'Her.—Roadsides, 11, 12, rare.

**Hypochoeris brasiliensis* (Less.) Griseb.—Waste places and roadsides, 9, 10, 17, 18, infrequent.

**H. glabra* L.—Waste ground along railroad in Donaldsonville, 18, rare.

Iva microcephala Nutt.—Dry, sandy, open places, common.

Krigia dandelion (L.) Nutt. (*Cynthia dandelion* (L.) DC.). Dwarf-dandelion.—Roadsides and dry, sandy fields, 9, 15, rare.

K. oppositifolia Raf. (*Serinia oppositifolia* (Raf.) Kuntze).—Moist, grassy places, roadsides, and waste places, 9, 11, 12, infrequent.

K. virginica (L.) Willd.—Dry, sandy fields, open woods, and barrens, common.

Kuhnia eupatorioides L. False-boneset.—Dry woods, 11, 14, rare.

Lactuca canadensis L. Wild lettuce.—Roadsides, old fields, waste places, and stream banks, frequent.

L. floridana (L.) Gaertn. (*Mulgedium floridanum* (L.) DC., *M. villosum* (Jacq.) Small). Blue lettuce.—Rich, dry or rocky woods, 5, 7, 11, 12, 18, infrequent.

L. graminifolia Michx.—Roadsides, 9, 11, rare.

L. hirsuta Muhl. (incl. var. *sanguinea* (Bigel.) Fern.).—Dry woods and old fields, 11, 17, rare.

**L. scariola* L. (incl. *L. virosa* L.). Prickly lettuce.—Waste places and roadsides, frequent.

Liatriis chapmanii Torr. & Gray. Blazing star. (*Lacinaria chapmanii* (T. & G.) Kuntze).—Reported only from 17 (Gaiser 1946).

L. elegans (Walt.) Michx. (*Lacinaria elegans* (Walt.) Kuntze).—Dry, sandy soils of pinelands, open woods, and old fields, common. A hybrid between *L. elegans* and *L. tenuifolia* Nutt. (X *Liatriis boykinii* T. & G.) is reported from 1 (Gaiser 1946).

L. gracilis Pursh (*Lacinaria laxa* Small, not *L. gracilis* of the Manual).—Dry, sandy soils of pinelands, oak barrens, and old fields, 11, 12, 17, infrequent.

L. graminifolia (Walt.) Willd. var. *elegantula* (Greene) K. Sch. (*Lacinaria gracilis* of the Manual).—Dry, open woods and sandy pinelands, frequent.

L. spherioidea Michx. (*Lacinaria aspera* (Michx.) Greene var. *spherioidea* (Michx.) Alex.).—Dry, open ground and open woods, 5, 9, infrequent.

L. spicata (L.) Willd. (*Lacinaria spicata* (L.) Kuntze).—Moist pinelands and sandy, open woods, frequent.

L. squarrosa (L.) Michx. (*Lacinaria squarrosa* (L.) Hill).—Dry oak woods and pinelands, 1, 5, 8, 9, infrequent.

L. squarrolosa Michx. (*Lacinaria scariosa* of the Manual, at least in part, *L. tracyi* Alex., *L. ruthii* Alex.).—Dry woods and sandy thickets, 11, 12, rare.

L. tenuifolia Nutt. (*Lacinaria tenuifolia* (Nutt.) Kuntze).—Sandy oak woods and barrens and dry pinelands, frequent.

Lygodesmia aphylla (Nutt.) DC.—Dry, sandy pinelands, oak woods, and barrens, frequent.

Marshallia graminifolia (Walt.) Small.—Rolling pinelands several miles west of Syl-vester, 8, rare.

M. obovata (Walt.) Beadle & Boynton.—Dry woods, 5, 7, 10, 11, 12, infrequent.

Melanthra nivea (L.) Small (*M. hastata* Michx.).—Woods along streams, 7, 9, 12, 17, 18, infrequent.

Mikania scandens (L.) Willd. Climbing hempweed.—Swamps and wet woods, very common.

**Parthenium hysterophorus* L. Ragweed, Santa Maria.—Waste places in towns, 9, 17, rare.

Pluchea camphorata (L.) DC. (*P. petiolata* Cass., not *P. camphorata* of the *Manual*). Marsh-fleabane—Margins of streams and ponds, swamps, wet woods, sloughs, and ditches, common.

P. foetida (L.) DC. Stinking-fleabane.—Shallow ponds, wet pinelands, and wet places in general, very common.

Polymnia uvedalia L. (*Smallanthus uvedalia* (L.) Mack.). Bear-foot.—Rich woods of ravine slopes, bluffs, and stream banks, 11, 12, 14, 17, 18, infrequent.

Prenanthes altissima L. (*Nabalus altissimus* (L.) Hook.). Gall-of-the-earth.—Rich woods on ravine slopes in the Red Hills, 5, 11, rare.

P. serpentina Pursh (*Nabalus serpentarius* (Pursh) Hook.).—Dry woods, frequent.

Pterocaulon undulatum (Walt.) C. Mohr. Black root.—Sandy, slightly moist pinelands, frequent.

Pyrrhopappus carolinianus (Walt.) DC. (*Sitilias caroliniana* (Walt.) Raf.). False-dandelion.—Roadsides and waste places, common.

Rudbeckia fulgida Ait. (incl. *R. spathulata* Michx.). Coneflower.—Dry, open woods and pinelands, 7, 8, 9, 10, 14, infrequent.

R. hirta L. Black-eyed Susan.—Dry woods and pinelands, common.

R. laciniata L.—Woods and fields, usually near streams, 7, 10, 11, 17, infrequent.

R. mohrii A. Gray.—Shallow cypress ponds and wet pinelands, common.

R. triloba L.—Dry, calcareous woods and roadsides, 5, 7, 9, rare.

Sclerolepis uniflora (Walt.) B.S.P.—Shallow water of cypress and pineland ponds, common.

Senecio glabellus Poir. Ragwort.—Swamps, wet woods, and bottoms along streams, frequent.

S. obovatus Muhl.—Rich woods, 5, 7, 12, 17, infrequent.

S. smallii Britt.—Dry woods and roadsides in the northern part of the area, 2, 5, 6, 7, 11, infrequent.

S. tomentosus Michx. (incl. *S. alabamensis* Britt.).—Grassy roadsides and open woods, 1, 7, 9, 11, 12, 14, infrequent.

Silphium asteriscus L. (incl. var. *angustatum* A. Gray). Rosin weed.—Dry, sandy soils of open woods, dry pinelands, oak barrens, and old fields, common.

S. compositum Michx. (incl. *S. ovatifolium* Small).—Dry, open woods and roadsides, frequent.

Solidago altissima L. (*S. hirsutissima* Mill.).—Roadsides and dry, sandy fields, common.

S. auriculata Shuttlw. (*S. notabilis* Mack.).—Rich, dry woods in the watershed of the Chattahoochee River, 5, 11, 12, 17, infrequent.

S. austrina Small.—Moist pinelands 3 miles east of Cordrays Mill, 10, rare.

S. bootii Hook. (incl. *S. yadkinensis* (Porter) Small).—Dry woods of ravines, bluffs, and stream banks, frequent.

S. brachyphylla Chapm.—Dry woods of ravine slopes and stream banks, 1, 5, 7, 9, 11, 12, 14, 17, infrequent.

S. caesia L.—Dry woods in the watershed of the Chattahoochee River, frequent.

S. fistulosa Mill.—Moist pinelands and moist meadows, 7, 9, 10, 13, 14, infrequent.

S. flaccidifolia Small (*S. latissimifolia* of the *Manual*).—Rich woods on the lower slope of a ravine near Fort Gaines, 11, rare.

S. gigantea Ait. (incl. *S. serotina* Ait., not Retz.).—Along streams and in open places, 4, 10, 11, 18, infrequent.

S. harperi Mack.—Dry, open woods by limestone quarry near Greer's Cave, 5, rare.

S. leavenworthii Torr. & Gray.—Low grounds on the Dougherty Plain, 7, 9, 14, 17, 18, infrequent.

S. microcephala (Greene) Bush (incl. *Euthamia minor* (Michx.) Greene).—Sandy, often moist pinelands, meadows, and old fields, common.

S. nemoralis Ait. var. *haleana* Fern.—Dry woods and pinelands, 1, 10, rare.

S. odora Ait.—Dry woods and pinelands, common.

S. patula Muhl. (*S. rigida* of the *Manual*).—Moist thickets at margin of boggy swamp near Hilton, 12, rare.

S. petiolaris Ait. (*S. milleriana* Mack.).—Dry woods, 5, 12, 14, rare.

S. puberula Nutt. (incl. *S. pulverulenta* Nutt.).—Dry woods, 5, 11, 12, 17, infrequent.

S. rigida L. (*Oligoneuron grandiflorus* (Raf.) Small, *O. jacksonii* (Kunze) Small.—Dry limestone overburden by quarry near Greer's Cave, 5, rare.

S. rugosa Ait. subsp. *aspera* (Ait.) Cronquist (*S. altissima* of the *Manual*, *S. celtidifolia* Small).—Dry woods and roadsides, 7, 9, 11, 12, 17, infrequent.

S. stricta Ait. (*S. petiolata* of the *Manual*).—Moist pinelands, wet meadows and bogs, 1, 8, 9, 12, 14, 18, infrequent.

S. tortifolia Ell.—Sandy pinelands, 7, 9, 10, 12, 14, infrequent.

**Soliva nasturtiifolia* (A. Juss.) DC. (*Gymnostyles nasturtiifolia* A. Juss.).—Lawns, roadsides, and waste places, 9, 10, 11, 12, 14, infrequent.

**S. sessilis* R. & P.—Roadsides and lawns, 12, 13, 17, rare.

**Sonchus asper* (L.) Hill. Sow-thistle.—Waste places and roadsides, common.

**S. oleraceus* L.—Waste places and roadsides, frequent.

Spilanthes americana (Mut.) Hieron. (incl. var. *repens* (Walt.) Moore).—Low grounds, 9, 14, rare.

(**Tagetes erecta* L. African marigold.—Spontaneous in a dump south of Albany, 9.)

**T. minuta* L.—Roadsides, 11, 15, 17, rare.

**Taraxacum erythrospermum* Andr. (*Leontodon erythrospermum* (Andrz.) Eichw.). Red-seeded dandelion.—Lawn in Albany, 9, rare.

**T. officinale* Weber (*Leontodon taraxacum* L.). Dandelion.—Lawns in the northern part of the area, 1, 5, 9, rare.

Tetragonotheca helianthoides L. Pineland-ginseng.—Dry, open woods and pinelands, frequent.

Trilisa odoratissima (Walt.) Cass. Vanilla plant, deer's tongue.—Moist pinelands, common.

T. paniculata (Walt.) Cass.—Moist pinelands, 7, 17, rare.

Verbesina aristata (Ell.) Heller (*Pterophyton aristatum* (Ell.) Alex.). Crown beard.—Dry, sandy oak-pine woods and pinelands, 9, 10, 12, 14, 15, infrequent.

V. occidentalis (L.) Walt. (*Phaethusa occidentalis* (L.) Small).—Bank of the Chatahoochee River near Neal's Landing bridge, 18, rare.

V. virginica L. (*Phaethusa virginica* (L.) Small). Frost weed.—Dry woods, frequent.

Vernonia acaulis (Walt.) Gleason (*V. oligophylla* Michx.).—Reported only from 1 (Harper 1906).

V. altissima Nutt.—Low grounds, swamps, and alluvial bottomlands, common.

V. angustifolia Michx.—Dry woods and pinelands, common.

V. gigantea (Walt.) Trelease.—Reported only from 14 (Gleason 1906).

V. missurica Raf.—Bogs, 5, 12, rare.

V. ovalifolia Torr. & Gray.—Dry woods of ravine slopes, bluffs, bottoms, and stream banks, 5, 6, 7, 11, 12, 14, 17, infrequent.

Xanthium strumarium L. (incl. *X. americanum* Walt., *X. pennsylvanicum* Wallr.). Cocklebur.—Roadsides, waste places, and fields, common.

(**Zinnia elegans* Jacq. *Zinnia*.—Rare escape in waste places and on roadsides, 5, 10, 12.)

STATISTICAL SUMMARY

Components of the Flora of Southwestern Georgia

Major Groups	Species		Genera	Families
	Native*	Introduced*		
"Pteridophytes"	32	1	19	8
Conifers	10	0	4	4
Monocotyledons	493	41	145	27
Dicotyledons	1004	166	467	111
Total	1539	208	635	150

* Ascertained as closely as possible.

Largest Families (with 20 or more species)

Compositae	225	Umbelliferae	31
Gramineae	194	Orchidaceae	29
Cyperaceae	164	Fagaceae	27
Leguminosae	106	Onagraceae	25
Liliaceae	43	Cruciferae	23
Scrophulariaceae	42	Ranunculaceae	22
Rosaceae	38	Rubiaceae	24
Ericaceae	32	Guttiferae	21
Euphorbiaceae	32	Convolvulaceae	21
Labiatae	32		

Largest Genera (with 10 or more species)

Carex	54	Xyris	13
Panicum	49	Eragrostis	12
Rhynchospora	34	Euphorbia	12
Quercus	24	Smilax	12
Cyperus	22	Viola	12
Eupatorium	21	Lespedeza	11
Solidago	21	Polygonum	11
Aster	20	Scleria	11
Desmodium	18	Vaccinium	11
Hypericum	18	Verbena	11
Paspalum	16	Aristida	10
Asclepias	15	Coreopsis	10
Eleocharis	15	Crataegus	10
Juncus	15	Ilex	10
Ludwigia	14	Utricularia	10
Polygala	14		

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Supplement to a Treatise on the North American *Ranunculi*

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Introduction

Since publication of *A Treatise on the North American Ranunculi* (Amer. Midl. Nat. 40[1]:1-261. 1948), 1) the writer has had unusual opportunities for continuation of study of the genus as it occurs in North America, and 2) the International Rules of Botanical Nomenclature have been revised.

Opportunities for study.—(a) In the summer of 1949 continued field study as a member of the teaching staff of the Montana State University Biological Station at Flathead Lake near Big Fork, Montana, together with collection of specimens in travelling over circuitous routes between California and Montana; (b) in the summer of 1950 study in England at the Herbarium of Linnaeus of the Linnaean Society of London, at the Royal Botanic Gardens, at Oxford University, and at the British Museum of Natural History; in France at the Muséum National d'Histoire Naturelle in Paris; in Switzerland at the Conservatoire Botanique in Geneva; and in Sweden at the Naturhistoriska Riksmuseet in Stockholm; (c) in the summer of 1950 field work in limited amounts in England, Switzerland, and southern Sweden, and more intensively in the vicinity of Lake Torneträsk in Swedish Lapland on an excursion arranged by the Seventh International Botanical Congress; (d) each year since 1948 determination of additional herbarium materials received as a result of appearance of *A Treatise on the North American Ranunculi*; (e) in 1950 and 1952 field research in the vicinities of Fairbanks and Point Barrow, on Kodiak Island, and in the Aleutian Islands, Alaska, on a research grant from the Arctic Institute of North America and through the courtesy of the Office of Naval Research of the United States Navy and the Arctic Research Laboratory at Point Barrow.

The information accumulated as the result of items (a) to (d) and part of (e) above is presented and evaluated in this paper; the rest on the *Ranunculi* occurring on the Alaskan Arctic Coastal Plain and in the Brooks Range of Alaska, accumulated as a result of (e) will be presented in the next issue. This is true, also, of studies on some of the same arctic species as they occur in Swedish Lapland.

As a result of the field observations and collections of the last two years the writer now has had an opportunity to study eighty-two of the North American species and varieties of *Ranunculus* in the field. In many instances there has been an opportunity for intensive analysis of local populations and for correlation of the occurrence of species of *Ranunculus* with ecologically associated plants of other groups. Records of these field studies on *Ranunculus* and

other genera are preserved in 15,100 specimens in the Pomona College Herbarium together with duplicates in other herbaria.

The following additions should be made to the list of symbols for herbaria (cf. Lanjouw, J. and F. A. Stafleu. *Index Herbariorum*. 1952) in which specimens have been studied (Treatise:5-7):

BM—British Museum of Natural History, London, England.

DAO—Division of Botany and Plant Pathology, Science Service, Department of Agriculture, Ottawa, Canada.

EWAN—Herbarium of Joseph Ewan, Tulane University, New Orleans, Louisiana.

G—Conservatoire et Jardin Botanique, Geneva, Switzerland.

K—Royal Botanic Gardens, Kew, England.

LINN—Herbarium of Linnaeus, or Linnaean Herbarium, Linnaean Society of London, England. Photographs of many Linnaean Herbarium specimens are at the Arnold Arboretum and at the Chicago Museum of Natural History.

MIN—Cf. UM below.

NO—Tulane University Herbarium, New Orleans, Louisiana.

OB—Oberlin College Herbarium, Oberlin, Ohio.

OXF—Fielding Herbarium, Druce Herbarium, Oxford University, Oxford, England.

P—Museum National d'Histoire Naturelle, Paris, France.

S—Botanical Department, Naturhistoriska Riksmuseet, Stockholm, Sweden.

SWC—Herbarium of the Experiment Station, Swift Current, Saskatchewan.

TENN—The Herbarium, University of Tennessee, Knoxville.

UM—Department of Botany, University of Minnesota, Minneapolis. Only a few specimens were cited in the Treatise, but accidentally the symbol as used was left out of the list; the standard symbol which should have been used is MIN. This is used in the present papers, which include study of the entire collection.

In addition to the herbaria listed above, the following is cited but not represented by a symbol: Herbarium of Sir James Edward Smith, Linnaean Society of London, England. Mention of collections included now in the larger ones listed above is by name (e.g. the DeCandolle Herbarium) with the symbol of the larger collection (e.g., G).

In addition to these collections, several individuals have sent large series of specimens for examination, permitting Pomona College to retain these sets. These specimens are cited under the Herbarium of Pomona College. Duplicates which have not been examined are in the herbaria of the collectors.

Revision of the International Rules of Botanical Nomenclature.—The writer attended all the sessions of the Section on Nomenclature at the Seventh International Botanical Congress (both at the Foregathering on Nomenclature and during the Congress). The changes in the International Rules of Botanical Nomenclature affecting *Ranunculus* were not extensive, although some were highly important (Many alterations pertained to the nomenclature of higher groups [divisions, classes, orders, and families] or of special groups requiring unusual rules [algae, fungi, fossil plants, hybrids, and horticultural plants]). The revisions of the Rules affecting the previous treatment of the North American *Ranunculi* fall under three headings as follows:*

1) *The name of the typical subgenus of a genus* (cf. articles 32 and 73).—The following recommendation was accepted by the Seventh International Botanical Congress at

* Cf. Lanjouw, J., et al. International Code of Botanical Nomenclature adopted by the Seventh International Botanical Congress, Stockholm, July, 1950. September, 1952.

Stockholm in 1950: "The subgenus containing the type species of a generic name must bear that name unaltered."

2) *The epithet used for the typical variety of a species.*—In this and similar cases, under the revision of the International Rules of Botanical Nomenclature adopted at Stockholm in 1950 (Art. 35), the typical variety of a species is indicated automatically by repetition of the specific epithet. Such epithets as *typicus*, *originarius*, etc. are not used. Authors' names are not necessary and are not cited. Article 35: "If any infraspecific taxon* which includes the nomenclatural type of the epithet of the next higher taxon is to be mentioned by a subdivisional name, that name must repeat the epithet of the higher taxon unaltered but, contrary to Art. 55, without citation of an author's name. This epithet can no longer be used when that of the next higher taxon is changed."

3) *The requirements for selection of a lectotype or neotype if the type (holotype) specimen of the species was not designated or if it is missing.*—Under the revised Art. 18, Note 3, of the International Code of Botanical Nomenclature adopted at Stockholm in 1950, "If no holotype [type] has been indicated by the author who described a taxon, or when the holotype is lost or destroyed, a substitute for it must be chosen. The author who makes this choice must be followed unless his choice is cancelled under the provisions of Art. 19." [Art. 19 is as follows: "The choice of a lectotype or neotype is cancelled if the original material is rediscovered, or if it can be shown that the choice was based on misinterpretation of the original description."]

"The substitute may be either a *lectotype* or a *neotype*. A lectotype always takes precedence over a neotype."

"A *lectotype* is a specimen or other element selected from the original material to serve as a nomenclatural type when the holotype was not designated at the time of publication or for so long as it is missing. . . ."

"A *neotype* is a specimen selected to serve as nomenclatural type for so long as all of the material on which the name of the taxon was based is missing."

The question of capitalization of certain specific epithets was debated twice at the Seventh International Botanical Congress. After the first of these discussions, the Section on Nomenclature voted 212 to 129 to modify the old Recommendation LIII to read as follows: "Specific and subspecific epithets should be written with a small initial letter." This was a decisive reversal of the previous recommendation on this small but troublesome point. However, by a later vote the following proposition was substituted (Recommendation 82G): "All specific and infraspecific epithets should be written with a small initial letter, though authors desiring to use capital initial letters may do so when the epithets are directly derived from the names of persons (whether actual or mythical), or are vernacular (or barbaric) names, or are former generic names." If the first proposition had been allowed to stand, the writer would have departed from his previous policy based upon the old Recommendation LIII for capitalization of certain specific epithets, because in minor matters of this sort, not worthy of argument, it is best to follow prevailing practice if prevailing practice can be determined. In view of rescinding of the original motion, prevailing practice is still in doubt, and capitalization of some specific names is retained for the present under the specific permission in the 1950 recommendation. Whether or not this practice will be continued remains to be decided. Proposal 2 concerning the International Code of Botanical nomenclature submitted to the Eighth International Botanical Congress—Paris 1954 has been published, Taxon 1(7):113. 1952. In it the writer has asked for

* A term officially accepted at Stockholm (Art. 8) is taxon (plural, taxa) which denotes a taxonomic group of any rank, (e.g. division, class, order, family, genus, species, variety).

decisive action to settle, by an Article (not a Recommendation), this question. Alternative proposals were submitted.

THE RELATIONSHIPS OF THE FLORA OF THE ALEUTIAN ISLANDS

The Aleutian Chain may be looked upon as an area at a relatively low latitude (mostly 52 to 54° N., the equivalent of British Columbia) with a severe climate maintained by the adjacent cold water of the Bering Sea. Heavy snow banks are restricted to the higher slopes because the severity of the weather is due not so much to low temperature (mostly 15 or 20 to 70° F.) as to wind, fog, and rain. Wind velocity is usually 10 to 50 miles per hour with gusts up to over 100; fog is abundant along the meeting area of the warm Japan Current and Bering Sea water; rain is frequent and it may be replaced by snow and sleet in the winter. Even in the short summer growing season (largely in the month of July) soil temperature is only about 40° F. Thus growing conditions approximating those above timber line in the mainland mountains or at sea level much farther north are prevalent even at sea level in the Aleutians.

Although the Aleutian Islands have the aspect of a tundra area with an arctic flora (Arctic Tundra*), the flora is alpine (partly West American Alpine Tundra* and partly of Asiatic origin). Many genera and some of the species occur above timberline in the mountains of the Alaskan mainland and southward to the Cascades and in lesser numbers to the Sierra Nevada and the Rocky Mountain System. The general appearance of the island flora and topography are reminiscent of the areas above timberline in western Washington, as, for example, on Mt. Rainier. However, as pointed out by Hultén (*Fl. Aleutian Islands* 21-44. 1937), the species of the islands and the Alaska Peninsula are chiefly those of the alpine slopes of Kamchatka rather than of North America. Although some arctic species are present, they are greatly outnumbered.

In some low sheltered canyons about Kodiak, there are colonies of species characteristically occurring in the lowlands from southern Alaska to the redwood belt of California, that is, the Pacific Forest. In some canyons, as just above Bells' Flats on the Kodiak Naval Station grounds, the Pacific Forest is represented clearly and distinctly and diluted but little by other species, but it arises to only 300 or 400 feet above sea level where it is replaced by a narrow zone of spruce (Sierran Subalpine Forest). In some areas, as for example northeast of Kodiak, the Pacific Forest is not represented clearly even at sea level, and there is a beautiful Sierran Subalpine Forest almost identical with that in the Cascade Mountains of Washington. Timberline is at only 2,000 feet, and the species occurring in the tundra above it are largely those abundant at all levels in the Aleutian Islands. On the Alaska Peninsula the forests disappear, there being along the shore at most a thin fringe of subalpine forest or of plants occurring in it.

The relationships of the flora of the Aleutian Islands to the alpine flora

* Cf. Treatise:10-16. Changes in nomenclature: Arctic Grassland and Tundra to Arctic Tundra; Alpine Grassland and Tundra to West American Alpine Tundra; Northern Forest to American Northern Forest.

primarily of Kamchatka and secondarily of Western North America rather than to the arctic flora, as at Point Barrow, explains the distribution of species of *Ranunculus* in the islands. There are some truly arctic species each known from only one to three islands, as follows:

<i>R. nivalis</i> L.	Atka, Unimak
<i>R. sulphureus</i> Soland.	Rat, Atka, Unalaska
<i>R. gelidus</i> Kar. & Kir.	Popof (Shumigan Islands)
<i>R. hyperboreus</i> Rottb.*	Kiska, Unimak

The following are both boreal and sub-boreal, i.e. in the forests near timber-line and circumpolar:

<i>R. Flammula</i> L. var. <i>filiformis</i> (Michx.) Hook.**	Amchitka, Attu, Kiska, Adak, Atka, Amlia
<i>R. aquatilis</i> L. var. <i>eradicatus</i> Laestad.	Popof (Shumigan Islands)

The following are Asiatic subalpine plants:

<i>R. acris</i> L. var. <i>frigidus</i> Regel	Buldir, Alaid
<i>R. kamchaticus</i> DC.	Rat, Atka, Carlisle

The first of the following list is strictly of West American Alpine Tundra (replaced in Kamchatka by var. *Hulténianus*); the other two are restricted largely to alpine and subalpine Alaska:

<i>R. Eschscholtzii</i> Schlecht. var. <i>Eschscholtzii</i>	General in the higher parts of all the islands
<i>R. occidentalis</i> Nutt. var. <i>brevistylis</i> Greene	General in the lower parts of all the islands; ranging to northern Alberta
<i>R. o.</i> var. <i>Nelsonii</i> (DC.) L. Benson	Near sea level on south-facing slopes and more general on the eastern end of the chain. Attu, Adak, Unalaska, Akutan, Akun, Unimak.

The following are characteristic primarily of the Pacific Forest of western North America (restricted to the eastern part of the chain):

<i>R. uncinatus</i> D. Don var. <i>parviflorus</i> (Torr.) L. Benson	Unimak, Unalaska
<i>R. aquatilis</i> L. var. <i>hispidulus</i> E. Drew	Unimak, Unalaska, Akutan

The following encircles the earth in North Temperate regions:

<i>R. aquatilis</i> L. var. <i>capillaceus</i> (Thuill.) DC.	General in lakes and ponds near sea level.
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RELATIONSHIPS OF THE *RANUNCULI* OF THE CONTINENTAL DIVIDE

In two earlier papers*** the writer has called attention to predominance of the section *Epirotes* in the Rocky Mountain Forests of North America and to occurrence of the same section in arctic and sub-arctic regions throughout the

* *R. hyperboreus* ranges also into Alpine regions, as for example the Rocky Mountains, but it is largely boreal.

** This plant ranges far southward in various types of forest.

*** The Relationship of *Ranunculus* to the North American Floras. Amer. J. Bot. 29:491-500. 1942.

A Treatise on the North American *Ranunculi*. Amer. Midl. Nat. 40:1-261. 1948.

Northern Hemisphere, as well as in the alpine regions of western North America and in the Rocky Mountain forests. This section is absent from the Pacific Northwestern Flora and the Sierra Madrean Flora as defined by the writer in 1942 and 1948. It is represented weakly in the Eastern Forest Flora by half a dozen species and varieties of an aberrant group. Study of the Mexican species of *Ranunculus* shows continuation of distribution of the section *Epirotes* into the Sierra Madre Occidental. The distribution of plants of the section *Epirotes* in western North America is summarized in table 1. The species and varieties occurring in these regions are related but different.

TABLE 1.—Summary of species and varieties of the section *Epirotes* in western N.A.

	Significant <i>Ranunculi</i>	<i>Epirotes</i>	Endemics	<i>Epirotes</i> Endemics
Arctic	11	9	4	4
Western Alpine	13	12	10	10
Rocky Mt. For.	17	12	12	9
Sierra M. Occ.	12	7	8	6
Totals	53	40	34	29

The North American species of the section *Epirotes* are confined to boreal regions and essentially to a north-south band along the Continental Divide from Canada into Mexico, and the group is almost unknown elsewhere on the continent. Although the forests and woodlands of the Pacific Region and of the Atlantic area apparently are favorable ecologically for *Epirotes*, the section is not represented (at least by typical members) in either place (table 2).

TABLE 2.—Distribution of species and varieties of the section *Epirotes* in N.A.

	Significant <i>Ranunculi</i>	<i>Epirotes</i>	Endemics	<i>Epirotes</i> Endemics
Boreal, Alpine, Rocky Mt. For., and Sierra Madre Occidental	53	40	34	29
Pacific North- western Flora	34	0	26	0
Sierra Madrean Flora	18	0	11	0
Eastern Forests	21	6*	20	5*

* Aberrant species within the the section.

Most species of *Ranunculus* occurring in the Pacific Northwestern, Sierra Madrean, and Eastern Forest Floras of North America are endemic members of other groups than *Epirotes*. These individual species groups are related to others occurring in miscellaneous areas outside North America. There is no comparably simple relationship of all or most of the species to those of any one special region, and relationship to Old World types are more remote. As shown by many plant groups, including the Gymnospermae and the Pterido-

phyta, the North American Pacific and Atlantic Floras are highly endemic; those of higher altitudes above the Continental Divide are related in many of their elements to sub-boreal floras occurring around the world.

The contrast in relationships of the species occurring in the ecologically more or less similar forests of the Rocky Mountain States and those of the Pacific States is particularly striking. On ecological grounds these forests have been divided primarily according to altitude rather than to mountain range, but in species composition they differ primarily according to mountain range, as indicated by *Ranunculus* and by other genera.

INTER-RELATIONSHIPS OF THE MEXICAN AND CENTRAL AMERICAN RANUNCULI

Except for the representatives of the section *Epirotes* in the Sierra Madre Occidental, the Mexican and Central American *Ranunculi* are chiefly of the *R. septentrionalis* group, centering in Mexico and endemic in the Western Hemisphere. The distribution pattern is in the form of a gigantic letter Y. The fork of the Y is in Mexico, and the two upper arms run northwestward as far as southern Alaska and northeastward to the Atlantic Coast of Canada. The basal stem of the Y runs from southern Mexico into Central America and it is continued southward in the Andes of South America. At the center of distribution in Mexico, the principal species are *R. macranthus*, *R. petiolaris*, *R. geoides*, and their numerous varieties, as well as *R. dichotomus*, *R. pilosus*, and *R. sibbaldioides*. Some species, as for example, *R. pilosus*, occur also in South America. The coincidence of some other North American species with some in South America is a subject for further study. In some instances the relationship is very close. In western North America there is a single species of the *R. septentrionalis* group—*R. orthorhynchus*, composed of five varieties. Its occurrence on the Pacific Coast may be due to migration of an ancestral type with the Sierra Madrean (Madro-Tertiary) Flora which moved northward in Oligocene time from the region of the Sierra Madre Occidental to the present Pacific Coast and Great Basin about as far as San Francisco and Salt Lake City. The northeastern arm of the Y is richer in species than the northwestern. It includes *R. septentrionalis*, *R. hispidus*, *R. carolinianus*, and their varieties—one of the principal species groups of the eastern United States and Canada. Although *R. orthorhynchus*, characteristic of the northwestern arm of the Y, is represented by its variety *platyphyllus* in mountains within and rimming the Great Basin, the *R. septentrionalis* group is absent otherwise from the Rocky Mountain system between the forks of the Y. This species group centering in Mexico and Central America long ago intruded the chief areas of endemic floras in North America, except most of the area dominated by the section *Epirotes*. However, in each of the endemic floras in which its species occur, the *R. septentrionalis* group is only one of several elements of the genus *Ranunculus*, and the other species show affinities with species groups in several other floristic regions.

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The aid of the Arctic Institute of North America, the United States Navy Office of Naval Research, and the Arctic Research Laboratory at Point Barrow under contract with the Office of Naval Research are acknowledged in part in the special paper on *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*. *Ranunculi* occurring in the Aleutian Islands, on Kodiak Island, and near Fairbanks were studied also as a part of the work under the research grant from the Arctic Institute of North America. Because the problems studied in these areas concern several species groups of *Ranunculi*, they are discussed in various parts of this *Supplement to a Treatise on the North American Ranunculi*, i.e. each at the point where the species is treated also in the light of new data from other sources. The writer is particularly appreciative of not only the valuable aid to this study by the Arctic Institute of North America and the Office of Naval Research but also by individual commanding and executive officers of Naval Stations and by a number of officers and enlisted men of the United States Navy without whose assistance effective field study would have been difficult. This aid was both on an official basis and informal, and the kindness and the friendly helpful spirit of all Naval personnel have made field work in Alaska both pleasant and successful.

Subgenus I. RANUNCULUS, replacing *Euranunculus* (Treatise:23-24)

KEY TO THE SPECIES (Treatise:26)

The following species are distinguished by bulbous stem bases from all others under lower lead 4 (Treatise: 26):

- 4b. Petals not bronzy-red dorsally, obovate-cuneate, 10-14 mm. long 7-10 mm. broad; achene beaks about 0.4 mm. long; basal leaves cordate in outline, usually pinnate or the earlier ones simple and with rounded lobes; leaves not densely appressed-tomentose on both surfaces, appressed-hirsute beneath. Introduced in mostly northern and eastern Temperate areas.)2. *R. bulbosus*
- 4b. Petals bronzy-red dorsally (with a reddish-purple or lavender appearance in dried specimens), obovate-oblanceolate, 8-12 mm. long, but only 3-4 mm. broad; achene beaks 1.5-2 mm. long; basal leaves flabelliform in outline, simple, parted, the lobes acute; leaves densely appressed-tomentose on both sides. (Jackson County, southern Oregon.)6 bis. *R. austro-oreganus*

1 RANUNCULUS REPENS L. (Treatise:29)

As noted on page 30, "Other varieties than those given here are differentiated poorly. Since they are native in the Old World, the writer has some caution about either reducing or recognizing them. However, they are not impressive as biological entities." After observing populations of *R. repens* in northern Europe and the Swiss Alps during the summer of 1950, the writer is less impressed than ever with the varieties segregated by some American authors under *R. repens*. The chief exception is *R. repens* var. *glabratus*, which was observed in Swedish Lapland at a number of localities in the vicinity of Lake Torneträsk, specimens having been obtained at Kopparäsen, L. Benson 14403 (POM). In Europe this variety occupies northern ecological niches similar to those it has taken over in the northern regions of North America. Except for var. *pleniflorus*, the other alleged varieties segregated by some

authors and recognized as occurring in North America are simply a few of the many biotypes to be found in the general population of *R. repens* in Europe. These minor biotypes are not worthy of formal names, because they do not represent segregated natural populations in Europe and they are not taxa.

1a *RANUNCULUS REPENS* var. *REPENS*, replacing var. *typicus* (Treatise:30)

Additional synonym.—*R. repens* L. var. *erectus* DC. Prodr. 1:38. 1924.

Additional significant specimens. IDAHO. ADAMS CO.: New Meadows, L. Benson 13786 (POM). OHIO. LORAIN CO.: Oberlin, Grover in 1932 (OB), in 1935 (OB); Paineville, Werner in 1887, (OB).

Type collections.—(1) *R. repens*. The following specimen is designated as a lectotype: Sheet number 52 (numbers applied by Spencer Savage) in the Linnaean Herbarium (Linnaean Society of London). The plant forming this specimen is glabrous. Sheet number 53, not a part of the lectotype is a very large, glabrous form with dissected leaves. It was collected by *Gemlin*. Lectotype (L). (2) *R. intermedius*, unchanged. (3) Var. *erectus*. The collection of this plant in the DeCandolle Herbarium at Geneva, Switzerland, is designated as a lectotype. It is typical *R. repens*. This fact was called first to the attention of the writer by Dr. Bernard Boivin, who visited Geneva earlier in the summer of 1950. Lectotype (G). (4) *R. Clintonii*, unchanged except as to number in this chronological series.

1b *RANUNCULUS REPENS* var. *GLABRATUS* DC. (Treatise:32)

Synonym: *R. lucidus* Poir. in Lam. Encyc. Meth. 6:113. 1804.

Collections cited under var. *erectus* (Treatise:33) as possibly representing that "variety" in North America (L. Benson 1334 and 1434 and Van Schaack 595) are referred now to var. *glabratus*. Var. *erectus* is a synonym of var. *repens* (cf. above).

Additional significant specimen.—NOVA SCOTIA. North Point Road, Brier Island, Smith, Roland, & Collins 296 in 1949 (POM).

Type collection.—None given, European. The collection of this plant in the DeCandolle Herbarium at Geneva, Switzerland, is designated as a lectotype for both *R. lucidus* and var. *glabratus*. Lectotype (G).

2 *RANUNCULUS BULBOSUS* L. (Treatise:34)

Additional significant specimens.—TENNESSEE. KNOX CO.: Knoxville, numerous collections (TENN). WASHINGTON CO.: Johnson City, W. H. Duncan 210-2, in 1934 (TENN). UNICOI CO.: V. Cook 31 in 1934 (TENN).

Type collection.—(1) *R. bulbosus*. The following specimen is designated as a lectotype: Sheet number 48 in the Linnaean Herbarium (Linnaean Society of London). Lectotype (L).

2a *RANUNCULUS ACRIS* var. *ACRIS*, replacing var. *typicus* (Treatise:36)

Additional synonyms.—*R. acris* var. *Stevenii* Lange f. *multiplicipetalus* Boivin, Can. Field Nat. 65:3. 1951. *R. acris* var. *acris* f. *plenus* Boivin, loc. cit.

The writer has not attempted to segregate varieties among the forms of *R. acris* introduced in North America. The form with less dissected leaves having more or less cuneate segments has been known in North America as var. *Stevenii*. As pointed out by the writer (Treatise:37), it is not that European plant but a far northern European race. It has seemed evident that the two minor forms have been imported into North America from the Old World, and observations in northern Europe in the summer of 1950 indicate this to be true. These two are a chance selection from a considerable number occurring in Europe, and their evident segregation in North

America is misleading because in their native habitat they are merely two of many minor forms in the general variable population of *R. acris*. Fernald, *Gray's Manual of Botany* ed. 8. 655. 1950, has identified the plant previously considered to be var. *Stevenii* with var. *latisectus* G. Beck. However, in view of the complexity of the field populations in Europe, distinction of varieties seems unwarranted. As with *R. repens*, this depends in part upon the author's concept of varieties, and recognition of them could be justified only on the basis of an exceedingly liberal interpretation. Study of European herbarium specimens and of living material on that continent indicates that *R. Boraeanus* Jordan (Treatise:38) is merely the opposite extreme in leaf dissection in *R. acris* from "var. *latisectus*."

This species is invading central Idaho and western Montana, as indicated by the following collections: 10 miles south of New Meadows, Adams County, Idaho, Hitchcock & Muhlück 13920 (UC); 12 miles northwest of St. Regis, Mineral County, Montana, L. Benson 13861 (POM); Arlee, Lake County, Montana, Hitchcock 18187 (WASH).

Ranunculus acris was collected at Kodiak, Alaska, in 1902 by Mylroie (NY, MIN) but evidently not by other collectors for a period of fifty years until 1952, L. Benson, 15000 (POM, US, and duplicates to be distributed). The species is abundant in waste places in the town, but it has not spread to the other accessible parts of the island, including even the pasture lands to the southwestward and the Naval Base. This is surprising in view of the rapid dissemination of the species in western Washington and elsewhere (Treatise:36). However, it is possible that the species was wiped out in 1912 when Kodiak was covered by a foot of volcanic ash from the tremendous eruption of Katmai 100 miles away and that it has been reintroduced only recently.

Additional significant collections.—CALIFORNIA. 5 miles west of Downieville, Grant Brown 162 (POM). NORTH CAROLINA. SWAIN CO.: Pin Oak Gap, Great Smoky Mountains, Glen Smith 2685 (TENN), Jennison 3789 (TENN). Stratton Meadows, Clebsch 1899 (TENN). MACON CO.: Highlands Arboretum and Biological Laboratory, Wilson & Underwood 2821 (TENN).

Type collection.—(1) *R. acris*. The specimens in the Linnaean Herbarium, Linnaean Society of London, are not wholly suitable as possible lectotypes. Nos. 55 and 58 (Savage's numbers) have leaves with three rather broad divisions, scarcely corresponding with the description ". . . foliis tripartito-multifidis: summis linearibus." Sheet number 56 is more nearly in harmony with the description. In this case, however, it seems better to designate as a lectotype the specimen used by Linnaeus in preparation of *Hortus Cliffortianus*, which he described as follows: ". . . foliis peltatis quinquangularibus, multipartitis: laciniis linearibus. . . ." Lectotype in the Hortus Cliffortianus collection of Linnaeus (BM). (4) *F. multiplicipetalus*, "Typus: L. Grant 658, Experimental Station, Kentville, Nova Scotia, June 14, 1938 (DAO)." (5) *F. plenus*, "Typus: J. M. Gillett 07-160-7 cultivated at the Dominion Arboretum and Botanic Garden, Ottawa, Ontario, June 29, 1939 (DAO)."

3b *RANUNCULUS ACRIS* var. *FRIGIDUS* Regel (Treatise:38)

The proper nomenclature for this variety is uncertain in view of the complexity of the mountain and arctic forms of *R. acris* occurring in the Old World. Collections from and field observations in the vicinity of Lake Torneträsk in Swedish Lapland (Snoritjåkko, north of Lake Torneträsk, 900 m., L. Benson 14491 (POM); source of the Hole Brook, near Låktatjåkko, south of Lake Torneträsk, L. Benson 14330 (POM), 14331 (POM), 14432

(POM)) indicate the occurrence in northern Europe of an arctic-alpine variety of *R. acris*. This plant differs little from the ones collected in the Aleutian Islands, and likely both are representatives of an arctic-alpine variety occurring across northern Eurasia. However, more study is needed to work out the classification and nomenclature of the forms and varieties of the *R. acris* complex. Intermediate forms between the north European variety and var. *acris* are abundant in Swedish Lapland at intermediate elevations (e.g. Låktatjåkko above Kopparåsen, 750 m., *L. Benson* 14441 (POM)). At low elevations var. *acris* is abundant (e.g. Kopparåsen, *L. Benson* 14405 (POM), 14407 (POM); Abisko (Turiststation), *L. Benson* 14383 (POM)). A form growing at Kopparåsen tends slightly toward the alpine variety, *L. Benson* 14406 (POM).

Additional specimens examined.—ALASKA. Buldir, Aleutian Islands, O. J. Murie 2097 in 1936 (S); Alaid, Hultén 6279 (S); Massacre Bay, Attu, Jørdal & Miller 2908 (MICH).

4 *RANUNCULUS TURNERI* GREENE (Treatise:38)

Additional specimens examined.—ALASKA. St. Lawrence Island, Bering Sea, H. L. Mason 6094 (S); Hall Island, Bering Sea, C. H. Townsend in 1886 (GH). YUKON. Rampart House, Porcupine River at the Alaskan Boundary, M. E. Murie 29, June 20, 1926 (S).

5a *RANUNCULUS ACRIFORMIS* var. *ACRIFORMIS*, replacing var. *typicus* (Treatise:41)

The Geyer collection referred to at the bottom of page 42 (Treatise) has been seen (BM). The Drummond collection was not located at either Kew or the British Museum of Natural History.

5b *RANUNCULUS ACRIFORMIS* var. *MONTANENSIS* (Rydb.) L. Benson (Treatise:43)

Type collection.—"MONTANA. Helena, 1891, F. D. Kelsey (type)." Type (NY). The line given in the Treatise was placed there through typographical error.

5c *RANUNCULUS ACRIFORMIS* var. *AESTIVALIS* L. Benson (Treatise:43, 250)

Additional specimen examined.—Add to M. E. Jones 5990 (BM).

6a *RANUNCULUS OCCIDENTALIS* var. *OCCIDENTALIS*, replacing var. *typicus* (Treatise:44)

Type collections.—(1) *R. occidentalis*. The Nuttall collection at Columbia University (New York Botanical Garden) was mentioned by Heller as the type. However, the plants before Nuttall when he wrote the description were presumably those in his own collection, and these are designated here as the lectotype. Lectotype (BM). Isotypes (in this case duplicates of the lectotype) include, then, the specimens cited previously as such (Treatise:44) and, in addition (NY, K—2 specimens, one in the Hooker Herbarium and one in the Bentham Herbarium). The Sitka, Alaska, collection by Bongard cited by Nuttall is var. *brevistylis*. A specimen is at Kew. (2) *R. tenuipes*. Additional isotypes (K, P, G, F 124618). (3) Var. *laevicaulis*. Additional isotypes (BM, F 223529, MIN 114200).

6d *RANUNCULUS OCCIDENTALIS* var. *ULTRAMONTANUS* Greene (Treatise:49)

Type collections.—(1) *R. alceus*. The type specimen has not been located (cf. Treatise:50). In the absence of other collections from Elk Mountain, Lake County, California, the following specimen from nearby Snow Mountain is designated as a neotype: Bear Creek, Snow Mountain, on the southwest side adjacent to Elk Mountain, 2,000 feet, Lake

County, California, *Lyman Benson* 3730, June 21, 1932 (POM 270006 (mounted on 2 sheets)).

6g *RANUNCULUS OCCIDENTALIS* var. *BREVISTYLIS* Greene (Treatise: 52)

Synonyms: *R. Schlechtendalii* Hook. Fl. Bor. Amer. 1:21. 1829. *R. repens* L. var. *hispidus* (Michx.) Chapman f. *Schlechtendalii* F. Kurtz in Engler, Bot. Jahrb. 9:358. 1894. *R. Nelsonii* (DC) A. Gray subsp. *insularis* Hult. Svensk. Bot. Tidskr. 30:526. 1936. *R. occidentalis* subsp. *insularis* Hult. Fl. Alaska and Yukon, Lunds Univ. Arsk. II. 40(1):762. 1944.

The styles are not hooked, and they are shorter than in var. *Nelsonii*. The plant is smaller than var. *Nelsonii*, and the characteristic sharply acute leaf lobes are wanting.

The range of this variety is extended to include the Aleutian Islands. The writer (Treatise:53) expressed uncertainty concerning the status of *R. occidentalis* subsp. *insularis* Hult., a plant occurring in the Aleutian Islands. Of the several collections in the Naturhistoriska Riksmuseum Herbarium at Stockholm, none has mature fruit, although the type specimen has one head of young fruits. Fortunately fruits are available from the following Aleutian Island and Bering Sea collections as well as those of the writer cited in the next paragraph: Hot Springs Bay, Tanaga I., *Bank* 339 (MICH); Nikolski Village, Umnak I., *H. A. Miller* 1123 (MICH, POM); Atka I., *Bank* 220 (MICH); The Seashore Caves, Kagamil I., *H. A. Miller* 1044 (US, MICH, POM); Kuluk Bay, Adak I., *Jordal* 2677 (POM, MICH), *H. A. Miller* 1167 (MICH); Nazan Bay, Atka I., *H. A. Miller* 1000 (MICH, POM, US); Kyska I., *W. H. Dall*, July 29, 1873 (GH), July 6, 1875 (GH); Middleton I., *Dall* in 1873 (GH).

The problem of segregation of the two varieties was a major reason for visiting the Aleutian Islands in 1952. Both occur on Adak, although var. *brevistylis*, the subalpine and alpine variety is more abundant. The subalpine and very low alpine var. *Nelsonii* of lower altitudes in the Aleutian Islands and the lowest fringe of the Alaska Peninsula occurs on Adak only at sea level on the south-facing slopes as on the coastal edge of Lake Andrew (*L. Benson* 14986 (POM, US), 14987 (POM, US), 14988 (POM, US)). The leaf segments are not quite as sharply acute as those of the extreme form, and the achene beaks are a little shorter than the maximum, being about 1.5 instead of 2 mm. long. The following plants from the other areas on Adak are clearly var. *brevistylis*, the dominant *Ranunculus* of the island up to 2,000 feet elevation where it reaches the lower limits of the range of *R. Eschscholtzii*: north-facing slopes at the inland edge of Lake Andrew, *L. Benson* 14978 (POM, US), and duplicates, 14984 (POM, US), 14989a (POM, US); mountains on the south side of Sweeper Cove, Kuluk Bay, southeast end of U.S. Naval Base, *L. Benson* 14943 (POM, US), and duplicates; southeast side of Mt. Moffett, 2,000 feet, *L. Benson* 14990 (POM, US).

Type collections.—(1) *R. Schlechtendalii*. The earliest known collection of var. *brevistylis* has a complex status from the nomenclatorial point of view. *R. Schlechtendalii* Hook. (cf. Treatise:85) was based upon "*R. fascicularis* Schlecht.", but the plants actually seen by Hooker were as follows: "Eastern declivity of the Rocky Mountains, between lat. 52° and 55°, in rich soils: plentiful. *Drummond*." Asa Gray, Proc. Amer. Acad. 21:372-3, 376. 1886, referred to Schlechtendal's specimens as the "type," of *R. Schlechtendalii*, and in view of both this and the epithet applied by Hooker, the writer accepted this combination for the plant but considered it as a synonym of *R. hispidus* var. *marilan-*

dicus (cf. change to var. *falsus*, species No. 18b). However, the collection by Drummond is largely *R. occidentalis* var. *brevistylis*. Drummond's name does not appear on the label, but his collection was presented to the British Museum of Natural History by Richardson, and the specimen there is almost certainly his. Four of the individuals on the specimen sheet are var. *brevistylis*; the fifth is *R. fascicularis* somehow mixed in from eastern North America. The duplicate at Geneva is all var. *brevistylis*. For nearly twenty years, the writer has been puzzled about the occurrence of any plant even remotely resembling *R. hispidus* var. *falsus* in the northern Rocky Mountains. Occurrence of a form of *R. occidentalis* seemed doubtful, too. In the last few years (Treatise:52) *R. occidentalis* var. *brevistylis* has been shown to occur over a broad area in Alaska and eastward to the Rocky Mountains in Alberta, and collection of this plant in the northern Rockies by Drummond is not surprising now. Hooker's description is drawn from both his specimens and Schlechtendal's description and figure. Hooker wrote as follows: "This plant agrees in every particular, as far as I can judge without fruit, with the description and figure above quoted of Schlechtendal's *R. fascicularis*, except that his figure represents a slenderer plant, and one of the leaves has the middle lobe petiolated, and the calyx not reflexed." Hooker's description included a characterization of the fruit, which must have been drawn from Schlechtendal, together with the words "... sepalis . . . reflexis," which could have been drawn only from the specimens, inasmuch as this is a key character of *R. occidentalis* as opposed to *R. fascicularis*. Although, the description was based upon two elements, Hooker was specific as to which characters were drawn from each, and selection of either as a lectotype would cause no serious confusion. According to Art. 21 (1952 code), "If it is later proved that such a type herbarium sheet or preparation contains parts belonging to more than one taxon, the name must remain attached to that part (lectotype) which corresponds most nearly with the original description." If the Schlechtendal specimen was not destroyed in the Second World War bombing of Germany it could be chosen as a lectotype. However, presumably it no longer exists, and the description was drawn at least equally from Drummond's specimens, the only ones seen by Hooker. Therefore, the four similar individuals on the sheet are designated as a lectotype, and *R. Schlechtendalii* is a synonym of *R. occidentalis* var. *brevistylis*. Fortunately, the epithet *Schlechtendalii* would not, according to present knowledge, replace any other regardless of the interpretation chosen. Lectotype (BM), isotype (G). (2) var. *brevistylis*. Additional isotype (MIN 114118). (3) subsp. *insularis*, "Aleutian Islands: Amchitka, July 9, 1932. Hn [Hultén] No. 6463 (type)." "Distributed to several European and American Museums." Type (S).

6h *RANUNCULUS OCCIDENTALIS* var. *NELSONII* (DC.) L. Benson
(Treatise:53)

Delete synonyms now appearing above under var. *brevistylis*, i.e. those with the epithet *insularis*.

This variety is characteristic of the warmer areas fringing the southwestern coast of Alaska, i.e. chiefly the Alaska Peninsula. It occurs on south-facing slopes at sea level in the Aleutian Islands, cf. discussion above under var. *brevistylis*. It is common on Unalaska. Some collections from farther out in the Aleutian Islands belong clearly to this variety. Examples are as follows: Sugar Loaf, Massacre Bay, Attu I., *Van Schaack* 408 (US, POM), 465 (US, POM), 467 (POM, US), 468 (POM, US); Chichagof Harbor, Attu I., *Van Schaack* 597 (POM), 604 (US, POM); Sidden's Valley, Attu I., *Hardy* 200 (POM, WASH); Akutan, G. N. Jones 8925 (WASH, POM); Atka I., *Dorsett* 444 in 1948 (MICH); Nazan Bay, Atka I., H. A. Miller 1021 (MICH, POM); Seguam I., *Bank* 950 (leaves like var. *brevistylis* but larger, achene beaks long) (POM, MICH, US); south slopes of hill between Lake Andrews and the Bering Sea, Adak I., L. Benson 14986 (POM, US), 14987 (POM, US), 14988 (POM, US) (a form with thick stems and leaves and densely hirsute herbage growing on the sand bar between Lake Andrews

and the Bering Sea; a localized form typical in many species of exposed sea-coasts).

Type collections.—(1) *Var. Nelsonii*. Type not found at Geneva. Isotype (BM) labelled "Unalaska, Dav. Nelson."

6 bis. *Ranunculus austro-oreganus* sp. nov.

Tomentose terrestrial perennials; roots about 1 mm. in diameter; stems erect or suberect, not rooting, 2.5-3.5 dm. long, 1.5-3 mm. in diameter, freely branching at least above, fistulous, sparsely spreading-tomentose below, soft-pubescent above, arising from a distinct bulbous base 5-8 mm. in diameter; basal leaf blades flabelliform in outline, 2.5-4 cm. long, 2.5-3.5 or 4 cm. broad, 3-parted (sometimes deeply so), the parts again 3-lobed, the lateral secondary lobes sometimes toothed, densely white appressed-tomentose, the base of the blade cuneate or sometimes obtuse or somewhat rounded, the petioles mostly 0.8-1.5 dm. long, thinly spreading-tomentose, the stipular leaf-bases 5-8 mm. long, broad, investing the tuberous stem base; cauline leaves alternate, the bracts of linear divisions, white-tomentose; pedicels mostly 4-8 cm. long in flower, 7-15 cm. long in fruit, pubescent; sepals 5, reflexed, ovate-acute, 4-5 mm. long, dorsally hairy and somewhat reddish- or lavender-tinged, about half the length of the petals, promptly deciduous; petals 5, bright yellow above, bronzy- or coppery-red dorsally, obovate-oblancoate, about three times as long as broad, 8-12 mm. long, 3-4 mm. broad, the nectary scale free laterally, apically with irregular teeth; stamens 25-40; achenes mostly 6-10 in a hemispheroidal cluster 6-7 mm. long and about 10 mm. in diameter, each achene asymmetrically elliptic-obovate, 3-3.5 mm. long, 2.5-3 mm. dorsoventrally, 0.3-0.4 mm. laterally, sometimes pilose basally, the margin well-marked but not prominent, the beak very slender, 1.5-2 mm. long, straight except for a minute hook at the tip, prolonging the apex of the body; receptacle 1 mm. long in flower, 2-3 mm. long in fruit, glabrous.

Herba perennis terrestris tomentosa; radicebus circa 1 mm. diametro; caulibus non e nodis radicanibus, 2.5-3.5 mm. longis, 1.5-3 mm. diametro, ramosis, fistulosis, base bulbosis; foliis flabelliformis, 2.5-4 cm. longis, 2.5-3.5 vel 4 cm. latis, tomentosis, tripartitis, in segmenta linearia vel cuneata 3-5 mm. lata divisis, sepalis reflexis, 4-5 mm. longis, ovatis-acutis, pilosis, circiter dimidio quam petalis-brevioribus; petalis 5, obovatis-oblancoatis, 8-12 mm. longis, 3-4 mm. latis, squamulis nectaris latere liberis, glabris; carpellorum capitulo subgloboso, circa 10 mm. diametro; acheniis circa 6-10, 3-3.5 mm. longis, 2.5-3 mm. latis, compressis; rostro non curvato, 1-1.3, 1.5-2 mm. longo; receptaculo 1-3 mm. longo, glabris.

Covering well-drained hillsides at about 1,500 to 2,000 feet elevation; mixture of California Oak Woodland and Pacific Forest. Jackson County, southern Oregon, on tributaries of the Rogue River in the hills east, north, and south of Medford and Ashland, ranging from Camp White to Emigrant Creek Reservoir. April and May. The plant is conspicuous and attractive.

The species should be named to honor any of the individuals who have collected it, and it is dedicated to all four of them: Mr. J. W. Thompson of Seattle, long-time botanical friend of the writer and the first collector; Dr. Helen M. Gilkey, Oregon State College, who has studied the plant thoroughly in the field; Professor Morton E. Peck, Willamette University, who has collected and studied the species in the field twice; and Mr. Louis Gentner,

Southern Oregon Branch, Oregon Agricultural Experiment Station, who called attention to the species and who has seen the plant most frequently in its native habitat.

Specimens examined.—OREGON, JACKSON CO.: Camp White, *Peck* 24868 (POM, WILLU), (type collection, cf. below); near Medford, *J. W. Thompson* 2122 (DS 171825, PA); Roxy Ann Peak road 3 miles east of Medford, *Gentner & Gilkey*, April 29, 1947 (OSC, POM); Emigrant Creek Reservoir, *Peck* 24916 (WILLU, POM).

Type collection.—Dry open slope, Camp White, Jackson County, Oregon, *Morton E. Peck* 24868, May 22, 1948 (POM 278441) (type); isotypes (WILLU, OSC).

8a *RANUNCULUS CALIFORNICUS* var. *CALIFORNICUS*, replacing var. *typicus* (Treatise:56)

Additional significant specimens.—CALIFORNIA (Sierra Nevada). MARIPOSA CO.: Hogan Mt., *Congdon* in 1894 (MIN); *Bassett's Congdon* in 1894 (MIN).

Type collections.—(1) *R. Deppei*, Type (BM) (the Nuttall Collection being deposited at the British Museum of Natural History and the specimen at the Academy of Natural Sciences of Philadelphia therefore being an isotype); additional isotype (K). (2) *R. dissectus*, Type (K—Hooker Herbarium); additional isotypes (K—Bentham Herbarium), (BM) (*Douglas* in 1833). (3) *R. californicus*, Type (K) additional isotypes (BM, G). Two collections with dissected leaves matching those of the type specimens of *R. dissectus* and *R. californicus* have come to light. These are as follows: CALIFORNIA, MONTEREY CO.: Monterey, *Elmer* 3529 (MIN); Castroville, *K. Brandegee* in April, 1899 (MIN).

8c *RANUNCULUS CALIFORNICUS* var. *CUNEATUS* Greene (Treatise:60)

Type collections.—(1) Var. *cuneatus*. The following specimen is designated as a neotype: Moss Beach (3 miles north of Half Moon Bay) San Mateo County, California, *L. Benson* 2618, March 3, 1931 (POM 268185). The writer would prefer to select an older San Mateo County collection, *C. F. Baker* 504 in 1902, (POM 150461, NY, UC, MO) but it is not as clearly the extreme form of var. *cuneatus*. Duplicate neotypes (NY, UC, MO). (2) Var. *crasifolius*. The specimen pressed in 1893 from material cultivated by Greene (cf. Treatise:61) is designated as a neotype. Neotype (UC 9409).

8d *RANUNCULUS CALIFORNICUS* var. *RUGULOSUS* (Greene) L. Benson (Treatise:61)

Additional specimens examined.—The following tend to fill in the apparent distributional gap between the Sacramento Valley and the San Joaquin Valley in California: SAN JOAQUIN CO.: 5 miles southwest of Ripon, *Hoover* 276 (UC). STANISLAUS CO.: Grayson, *Hoover* 289 (UC); La Grange, *Hoover* 3907 (UC, POM).

9a *RANUNCULUS CANUS* var. *CANUS*, replacing var. *typicus* (Treatise:64)

Additional specimens examined.—The following tend to fill in the sparse known distribution in the San Joaquin Valley: STANISLAUS CO.: 8 miles east of Oakdale, *Hoover* 755 (UC). MERCED CO.: 2 miles east of Snelling, *Hoover* (number not recorded) (UC); East base of Pacheco Pass, *Hoover* 1674 (POM) (another collection under this number being *R. californicus* var. *rugulosus* (UC)). TULARE CO.: Success, *Hoover* 751 (UC, POM).

Type collections.—(1) *R. canus*. Type (K—Bentham Herbarium); additional isotypes (BM, G—exceedingly hirsute-canescens, the hairs white, P). (3) *R. longilobus*. Additional isotype (G).

9b *RANUNCULUS CANUS* var. *LAETUS* (Greene) L. Benson (Treatise:66)

Additional specimens examined.—The following collections extend the known range southeastward: CALIFORNIA. STANISLAUS CO.: Modesto, *Hoover* 292 (UC); Oakdale, *Hoover* 788 (UC).

11a *RANUNCULUS UNCINATUS* D. Don var. *UNCINATUS*, replacing
var. *typicus* (Treatise:69)

Type collections.—(1) *R. uncinatus*. Additional isotype (G—"Mexique, Moc. & Sessé. Herb. Lambert"). Recently, Dr. H. W. Rickett, *Chronica Botanica* 11(1):1-86. 1947, has published a detailed account of the botanical travels of Mociño and Sessé in Mexico. According to this account, Mociño travelled not only in Mexico as it is understood today but also on an expedition to Alaska, claimed then as a part of Mexico. He spent a winter at Nootka (Nutka), Alaska, and collected plants in the vicinity. It is almost certain that his collection of the type of *R. uncinatus* was made in Alaska, probably at Nutka, and that the species does not occur in Mexico. This may clear up an apparent freak of geographical distribution difficult to explain otherwise. (2) *R. tenellus*. Type (BM).

11b *RANUNCULUS UNCINATUS* var. *PARVIFLORUS* (Torr.) L. Benson
(Treatise:71)

Field study on Kodiak Island near the extreme northwest limit of the range of this variety (20 miles south of Kodiak Naval Station, *L. Benson* 15015 (POM, US)) indicates only var. *parviflorus* to be present. However, the achene beaks are a little shorter than average, and the hairs are restricted largely to the margins of the achenes. Var. *uncinatus* seems to be restricted to the interior in Alaska; it is primarily of the interior areas throughout its range.

Additional significant specimen.—CALIFORNIA. MARIN CO.: Head of Drake's Estero, Hoover 5059 (UC, POM).

Type collections.—(1) Var. *parviflorus*. (US 1100) (cf. Treatise:73) is designated as a lectotype, or if it can not be shown to be part of the original material of var. *parviflorus*, as a neotype. (2) Var. *Lyallii*. Additional isotype (K).

11c *RANUNCULUS UNCINATUS* var. *EARLEI* (Greene) L. Benson
(Treatise:73)

Additional specimens examined.—COLORADO. GUNNISON CO.: Gothic, *Langenheims* 580 in 1948 (POM); Rustler's Gulch, *Langenheim* 852 in 1950 (POM) (petals 6 mm. long), 1500 (POM and sheets to be distributed) petals of about half the numerous individuals in the collection 5-6 mm. long, the others 4 mm. long, the latter assigned the number 1500A by the writer because of their close approach to var. *uncinatus*, the fruit as in var. *Earlei*.

Type collection.—Additional isotype (MIN 113217).

12a *RANUNCULUS RECURVATUS* var. *RECURVATUS*, replacing var.
typicus (Treatise:74)

Type collections.—(1) *R. recurvatus*. Type (P) on 2 sheets, photographs of both (POM). (2) *R. saniculaeformis*. "Delaw.," i.e. Delaware. There is no specimen in the Muhlenberg Herbarium (PA—American Philosophical Society). Specimens in European herbaria labelled *R. saniculaeformis* Muhl. are as follows: "Am. Sept. M. le Capne. LeConte," (P) (not the type collection but perhaps indicative of what was passing under this name); "N. Yk. and M. . . ." (G) (of the same significance as the plant at Paris). The specimen at Paris is designated as a neotype. (3) *R. hirtus*, nom. nud. Type (PA—American Philosophical Society). The species following, i.e. (3), must be renumbered by adding one in each case.

R. lanuginosus Walt., Fl. Carol. 159. 1788 is perhaps this species because the specimen labelled *R. lanuginosus* Walt. in the DeCandolle Herbarium at Geneva is *R. recurvatus*. However, there is no indication that it was sent or collected by Walter. Obviously, the epithet applied by Walter has clear priority over that of Poiret, should the two prove synonymous.

R. recurvatus var. *minor* Hook. J. Bot. 1:187. 1834, has not been seen. *Type collec-*

tion.—"Pennsylvania [Drummond]." The collection by a Mr. Greene from "near Charleston, S. Carolina" also mentioned by Hooker may be *R. carolinianus*, in view of the disposition to become stoloniferous.

12b *RANUNCULUS RECURVATUS* var. *TROPICUS* (Griseb.) Fawc. & Rendle (Treatise:75)

Type collections.—(2) *R. cubensis*. Type (BM), isotype (G—filed in the South American collection).

13 *RANUNCULUS PENNSYLVANICUS* L. f. (Treatise:76)

Type collections.—(1) *R. pensylvanicus*. Sheet number 47 in the Linnaean Herbarium, Linnaean Society, London, is *R. pensylvanicus*. It bears the label, "*Ranunculus Canadensis hirsutissima tenuifolia flore luteo parva*. CB." According to Savage, this is in Thouin's handwriting. In the absence of a clear type specimen, this sheet is designated as a neotype. Cf. also below. (2) *R. canadensis*. Specimens in the Herbarium of Jussieu (P), labelled "*R. canadensis* Jaqu." are the well-known *R. pensylvanicus*. There are three sheets with no significant data; one of these alone bears the legend, "ex hort. 1759." In the Herbarium of Bishop Goodenough (K) are two specimens of the same species mounted on a single sheet. One is labelled, "*R. pensylvanicus* sp. nov. 1785," and it may be an isotype of that species, though the date would not indicate it to be so. The other is labelled *R. canadensis*. According to information kindly supplied by Dr. H. W. Rickett of the New York Botanical Garden, there is no information clearly establishing publication dates within the year 1781 for *R. pensylvanicus* and *R. canadensis*, pending obtaining further information, the traditional acceptance of priority for *R. pensylvanicus* is followed.

14 *RANUNCULUS MACOUNII* Britt. (Treatise:77)

Type collections.—(2) *R. Macounii*. This was based upon collections by Scouler and by Douglas from the Pacific Coast of North America. Since there are two good specimen sheets, the specimens labelled "Columbia," collected on the Columbia River by Scouler are designated (2 sheets together) as a lectotype. Lectotype (K). A specimen based upon "*R. hispidus* Hook." and labelled "Fl. Bor. Am." is at Geneva.

15 *RANUNCULUS PACIFICUS* (Hult.) L. Benson (Treatise:79)

Type collection.—Hoonah, Chichagof Island, I. L. Norberg 198b, July 13, 1932. Type (S).

16 *RANUNCULUS SEPTENTRIONALIS* Poir. (Treatise:80)

Delete the following synonyms: *R. lucidus* Poir. in Lam. Encyc. Meth. 6:113. 184, not Moench in 1794 (= *R. repens* L. var. *glabratus* DC.). *R. tomentosus* Poir., loc. cit. 127 (= *R. hispidus* Michx. var. *eurylobus* L. Benson).

Additional significant specimens.—TENNESSEE. 4½ miles southeast of Salt Lick, Wharton 5965 (TENN); Fayetteville, Sharp & Adams 10888 (TENN, POM) (no fruit; possibly *R. carolinianus*). ANDERSON CO.: Savage Garden, Coal Creek, Jennison 473 in 1934 (TENN). KNOX CO.: Several collections (TENN). BLOUNT CO.: Perley Anthony Branch, Jennison 28 in 1938 (TENN). NORTH CAROLINA. SWAIN CO.: Andreas Bald, Great Smoky Mountains, Jennison 3854 (TENN).

Type collection.—(1) *R. septentrionalis*. Type (P). (2) *R. Belvisii*. Type (G—DeCandolle Herbarium). (3) *R. nitidus*. Renumber from here on in accordance with deletion of 2 numbers for *R. lucidus* and *R. tomentosus*, cf. above.

17 *RANUNCULUS CAROLINIANUS* DC. (Treatise: 82)

Additional synonym.—*R. carolinianus* var. *villicaulis* Shinnery, Field and Laboratory 18:84. 1950. Collections from four localities in Texas have hirsute stems, a character uncommon in this species but occurring occasionally elsewhere. These were described from isolated plants as var. *villicaulis*. According to the policy of the writer such minor entities

should be recorded and described but not named. This is a matter of individual policy, however.

It is possible that the following series of combinations is based upon specimens of this species and that the combination *R. carolinianus* DC. must be replaced by *R. marylandicus* Poir.: *R. marylandicus* Poir. in Lam. Encyc. Meth. 6:126. 1804. *R. septentrionalis* Poir. var. *marylandicus* Torr. & Gray, Fl. N. Amer. 1:21. 1840 *R. hispidus* Michx. var. *marylandicus* L. Benson, Amer. Midl. Nat. 40:84. 1948. Type collection.—*R. marylandicus*, "Cette plante croît au Maryland . . . in herb. Bosc." However, DeCandolle, Syst. 1:291. 1818, wrote as follows: "Hab. in Marylandia, Bosc, in sylvis opacis à Pensylvaniâ ad Virginiam (Pursh . . . fl. maio-Jul. (v.s. sp.)." No specimen was found at Paris, and in response to a subsequent inquiry Mr. J. Leandri states that none is there. Correspondence indicates that no specimen is in the portions of the Bosc collections at the University of Neuchâtel, Switzerland, or the University of Padua, Italy. A single specimen labelled *R. marylandicus* is in the DeCandolle Herbarium at Geneva. The specimen (G), photograph (POM), has only young fruits, but they have unmistakably the developing wings typical of the mature achenes of this species. This specimen may or may not have been collected by Bosc in Maryland. The only indication of a locality is "Richmond." This may have been either Richmond, Virginia, or a former Richmond, Maryland, and it is possible that Poirêt merely guessed Richmond was in Maryland. The earliest Gazetteer for Maryland in the Library of Congress (1852) has no reference to a Richmond, Maryland (courtesy of Mr. Donald G. Patterson, Acting Chief, General Reference and Bibliography Division). According to Dr. Russell G. Brown of the Botany Department of the University of Maryland, the current gazetteer of Maryland lists a Richmond in Charles County, southeast of Washington on the lower Potomac River, but the Geological Survey map (circa 1900) does not show it. According to Mr. Morris L. Radoff, Archivist of the Hall of Records in Annapolis, the Richmond listed in the gazetteer can not be found, and ". . . persons who know . . . [Charles] county [one of the earliest to be settled] well have never heard of it." According to Mr. Patrick J. Mudd, Clerk, Circuit Court of Charles County, "So far as I have been able to determine there is not nor ever has been a place named Richmond in Charles County, Maryland." Pending further research the epithet *marylandicus* is not used for either this species or *R. hispidus* var. *falsus* (cf. No. 18b).

Additional significant specimens.—MINNESOTA. Bear Point, Itasca Park, Moyle 2717 (MIN). STEARNS CO.: Paynesville Township, Moore & Phinney 12633 (MIN). HENNEPIN CO.: Sandberg (MIN). CARVER CO.: Shakopee, Ballard B174 in 1891 (MIN). RAMSEY CO.: Groveland Park, Sheldon in 1895 (MIN). LE SUEUR CO.: Lake Washington, Sheldon in 1891 (MIN). FILLMORE CO.: Chatfield, Rosendahl & Butters 2944 (MIN). Other collections are not of certain identification for lack of fruit. IOWA. MUSCATINE CO.: Muscatine, Shimek in 1928 (MIN). PENNSYLVANIA. ALLEGHENY CO.: Chartier's Creek, Mayview, Bright 9151 (MIN).

Type collections.—(1) *R. carolinianus*. "Hab. in Carolina inferiore. Bosc." Type (P—Poirêt Herbarium, but housed in General Herbarium) ("flore minore, calica subreflexo. Bosc. Caroline N. [or H.] Poirêt"). A specimen sheet in the General Herbarium at Geneva has the following written upon it: "*R. hispidus* var.—Michx." "Caroline, Bosc." "Scripsit A.P.DC.") The fruits are young but with developing wings, and there is no doubt the plant is this species. (3) Var. *villicaulis*, "Type, Freeport, Brazoria County, Texas, George L. Fisher 48102, March 21, 1948 (in Herb. Southern Methodist Univer-

sity)." The type and other specimens were sent on loan through the kindness of Dr. Lloyd H. Shinners.

18a *RANUNCULUS HISPIDUS* var. *HISPIDUS*, replacing var. *typicus*
(Treatise:84)

Type collections.—(1) *R. hispidus*. Type (P—Michaux Herbarium) ("In umbrosis Virginiae, Carolinae"), photograph (POM).

18b *RANUNCULUS HISPIDUS* var. *FALSUS* Fern., at least temporarily
replacing var. *marylandicus* (Treatise:84)

Omit synonym, *R. Schlechtendalii* Hook., cf. 6g. *R. occidentalis* var. *brevistylis*. Omit also *R. repens* var. *hispidus* f. *Schlechtendalii* F. Kurtz.

The following epithet and the combinations based upon it are of uncertain application: *R. marylandicus* Poir. in Lam. Encyc. Meth. 6:126. 1804. Study of the single specimen at Geneva indicates this epithet may have been applied to the plant heretofore treated as *R. carolinianus* (cf. discussion under species no. 17). The earliest clearly applied epithet of varietal rank remaining is *falsus*, and it is adopted for the time being.

18c *RANUNCULUS HISPIDUS* var. *EURYOLOBUS* L. Benson (Treatise:85)

Additional synonym.—*R. tomentosus* Poir. in Lam. Encyc. Meth. 6:127. 1804, not Moench in 1794.

Type collections.—(1) *R. tomentosus*, "Cette plante a été recueillie par M. Bosc dans la Haute-Caroline." Possible isotype (BM—Nuttall Herbarium), labelled, "N. Carol." The writer has a strong memory of having seen later the type in the collection at Paris or Geneva, but notes taken there do not record it.

18d *RANUNCULUS HISPIDUS* var. *GREENMANII* L. Benson (Treatise:86)

Additional specimens examined.—TENNESSEE. Great Smoky Mountains. BLEDSOE CO.: Low Gap, Shanks, Clebsch, & Sharp 4434 (TENN). BLOUNT CO.: Deal's Gap, Jennison 2244 (TENN); State Line Gap, Vic Gregory Mountain, Jennison 191 (TENN); White Oak Sink, Sharp S-04112 (TENN).

19a *RANUNCULUS PETIOLARIS* var. *PETIOLARIS*, replacing var. *typicus*
(Treatise:89)

Note that *R. Galeottii* is a synonym of species 21, *R. pilosus*.

Additional specimen examined.—VERA CRUZ: Coatepec, Goodman 3373 (POM); "Prov. de Vera Cruz, htoar 3000. Mexique, Coll. de J. Linden 967, fl."

Type collection.—Type (P—H. B. K. Herbarium) ("S. Rosa, Mexic."), photograph (POM); no isotype in DeCandolle Herbarium (G).

19b *RANUNCULUS PETIOLARIS* var. *SIERRAE-ORIENTALIS* L. Benson
(Treatise:89)

Additional significant specimen.—MEXICO. NUEVO LEON: 8 miles east of Dulces Nombres, 1550 m., Meyer & Rogers 2584 (POM).

19c *RANUNCULUS PETIOLARIS* var. *HOOKERI* (Schlecht.) L. Benson
(Treatise:90)

Type collection.—Isotype (BM).

19d RANUNCULUS PETIOLARIS var. MEXIAE L. Benson (Treatise:91)

Type collection.—Additional isotypes (G, BM).

20a RANUNCULUS GEOIDES, replacing var. *typicus* (Treatise:91)

Additional synonym.—*R. multicaulis* D. Don in G. Don, Gen. Syst. Gard. 1:34. 1831 (cf. Treatise:250).

Additional specimens examined.—MEXICO. San Jose Iturbide, 5 miles west of Cerro Zamorano, 2600 m., McVaugh 10403 (MICH); northeast of Hidalgo, McVaugh 9977 (MICH).

Type collections.—(1) *R. geoides*. Type (P—H. B. K. Herbarium), "Bonpl. n 4097. Moran, Mexicanorum", photograph (POM). (2) *R. multicaulis*, "Native of Mexico". "D. Don in Herb. Lamb [ert]". Isotype (G) ("Mexique—Moc. & Sess."). The collections from Mexico in the Lambert Herbarium were from Mociño and Sessé. (3) *R. longepedunculatus*. Type or isotype (P).

20b RANUNCULUS GEOIDES var. OAXACENSIS (Briq.) L. Benson
(Treatise:93)

Additional specimen examined.—OAXACA: Cañon of Rio Zaveleta near the village of San Pablo Cuatro Venados, 15-18 km. west southwest of Oaxaca, Camp 2530 (NY).

Type collection.—Type (G); additional isotypes (P, K, MIN 113985).

20c RANUNCULUS GEOIDES var. AMELLUS (Briq.) L. Benson
(Treatise:93)

Additional significant specimens.—MEXICO. HIDALGO: It should be noted that the following plant, though cited (Treatise:92) as var. *geoides* (*typicus*) may be a little closer to var. *amellus*: Mineral del Monte, Zerezo below Parque National El Chico, H. E. Moore, Jr. 3152 (POM). A similar collection is from Mineral del Chico in the same region, H. E. Moore, Jr. 1544 (POM). In each of these specimens the stem base is hirsute, however.

Type collection.—Type (G) (plant at top of the sheet; duplicate attached on card may or may not have been there when Briquet annotated the specimen in 1908); additional isotypes (K, P, MIN 113722).

21 RANUNCULUS PILOSUS H. B. K. (Treatise:94)

Additional synonym: *R. Galeottii* Turcz. Bull. Soc. Nat. Mosc. 27:276. 1854, cf. Treatise:89.

Type collections.—(1) *R. pilosus*. Type (—H.B.K. Herbarium) ("S. fe de Bogota"), photograph (POM); isotypes (P—General Herbarium) (also "S. fe de Bogota") (G—DeCandolle Herbarium). (3) *R. Galeottii*, "Mexico, Oaxaca, alt. 7,000-9,000 ped. Galeotti n. 4,567." Isotype (G) ("Montia 8500 Cordillera (Oaxaca Mexico, H. Galeotti 4567, Sept. 1840).")

22a RANUNCULUS ORTHORHYNCHUS var. ORTHORHYNCHUS, replacing
var. *typicus* (Treatise:96)

Type collection.—(1) *R. orthorhynchus*. Type (K—Hooker Herbarium) (leaves dissected); isotypes (K—Bentham Herbarium), (GH) (uncertain).

22c RANUNCULUS ORTHORHYNCHUS var. ALASCHENSIS L. Benson
(Treatise:99)

Type collections.—(1) var. *alascensis*. Additional isotype (MIN 113209).

23a RANUNCULUS FASCICULARIS var. FASCICULARIS, replacing var.
typicus (Treatise:102)

Type collections.—(1) *R. fascicularis*. Authentic material (G—DeCandolle Herbarium) ("Bigelow, 1817"). A sheet in the Muhlenberg Herbarium (PA—American Philo-

sophical Society) bears only the notation "*Ranunculus fascicularis* 787". The writing is by Dr. R. E. Griffith, about 1830, and any data from Muhlenberg are missing. There were two plants of *P. rhomboideus* on the sheet. The other individual is *R. fascicularis*. In the absence of other specimens clearly belonging to Muhlenberg the specimen of the American Philosophical Society is designated as a lectotype (PA). The two plants of *R. rhomboideus* have been placed on another sheet.

23b *RANUNCULUS FASCICULARIS* var. *APRICUS* (Greene) Fern.

(Treatise:103)

Additional significant specimens.—GEORGIA. Lower Georgia, *Rugel* in 1843 (BM). CRAWFORD, PEACH, or HOUSTON CO.: Between Knoxville and Perry, *Rugel* in 1845 (BM).

Type collections.—(1) *R. apricus*. Additional isotype (K).

23c *RANUNCULUS FASCICULARIS* var. *CUNEIFORMIS* (Small) L. Benson

(Treatise:103)

Type collections.—Additional isotype (P).

24a *RANUNCULUS MACRANTHUS* var. *MACRANTHUS*, replacing var.

typicus (Treatise:105)

Type collections.—(1) *R. delphinifolius*. Type (P—H. B. K. Herbarium) ("Bonpl. no. 4089. Real del Monte"), photograph (POM); additional isotypes (P—General Herbarium), none found in the DeCandolle Herbarium (G). (3) *R. fasciculatus*, a plant in the General Herbarium at Geneva is labelled as *R. fasciculatus* Moc. & Sess. ("Mexique"). It is *R. petiolaris* H. B. K. This is not in harmony with the collection at the Chicago Museum of Natural History (F 846434), which is designated as a lectotype of *R. fasciculatus* in order to clarify the situation. Fortunately, *R. petiolaris* and *R. macranthus* have clear priority over *R. fasciculatus* for their respective taxa. (5) *R. Lindenianus*. Type (G); isotype (P). (6) *R. Pringlei*. Type (G); additional isotypes (BM, P). (7) *R. Townsendii*. Type (G), photograph (BM); additional isotypes (BM, P).

25 *RANUNCULUS DICHOTOMUS* Moc. & Sess. (Treatise:107)

Additional synonym.—*R. dichotomus* var. *limnobius* Briq. Ann. Conserv. & Jard. Bot. Genève 11 & 12:178. 1908, cf. Treatise:108.

Type collections.—(1) *R. dichotomus*. Type, not found in the H. B. K. Herbarium (P). The species was published first for Humboldt, Bonpland, and Kunth by DeCandolle. However, no specimen was found at Geneva, either. (2) *R. Llaveanus*. Additional isotypes (P, G—Moriciand Herbarium, BM, K). (3) Var. *limnobius*. Type (G—"Fl. Jaunes. Laes a 7000—"), Cordillera (Oaxaca), Mexico, *H. Galeotti*, May, 1840.

26 *RANUNCULUS SIBBALDIODES* H. B. K. (Treatise:108)

Additional synonym.—*R. praemorsus* H. B. K. var. *sibbaldioides* (H. B. K.) Lourteig, Darwiniana 9:532, f. 42. 1951. However, the writer is not certain now that the Andean plant of South America is the same as that in Mexico, which is being restudied.

Type collection.—Type (P—H.B.K. Herbarium), no locality given, photograph (POM).

27 *RANUNCULUS HEBECARPUS* Hook. & Arn. (Treatise:110)

Type collections.—(2) *R. hebecarpus*. Type (K—Hooker Herbarium); additional isotypes (K—Bentham Herbarium), (BM) (Nova California, *Douglas* in 1833).

28 *RANUNCULUS PARVIFLORUS* L. (Treatise:111)

Type collection.—The following specimen in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype. Sheet number 67, which, according to Fowell, is *Ranunculus* species number 12 of Hortus Cliffortianus. The specimens are young but with fruits.

28 bis. *RANUNCULUS PLATENSIS* Sprengel, Syst. Veg. 5:586
(Index). 1827

Casalea sessiliflora St. Hil. Fl. Bras. Mer. 1:9. 1825 (*R. sessiliflorus* Sprengel in 1827, not *R. Br.* in 1818).

Weak-stemmed terrestrial annuals; stems 2-4 dm. long, about 0.5 mm. in diameter, thinly pilose; leaves largely cauline, the blades reniform in outline, about 1 cm. long, 1.5-1.8 cm. broad, 3-parted and the parts again 3-5-lobed (the middle one 3-lobed), the petioles about 2-4 cm. long, the upper leaves reduced gradually; *flowers sessile, appearing along the stem*; *sepals* 3, usually concave, about 2 mm. long; *petals* 3, about 2 mm. long, less than 1 mm. broad; achenes about 8-15, each obovate, biconvex, markedly muriculate on the faces, the margin narrow but distinctly differentiated especially apically, the beak minute, but relatively broad, sharply curving; receptacle about 1 mm. long in fruit, glabrous.

Ditches; Houma, Louisiana. Known from a single North American collection. Probably introduced from South America.

The species is distinguished from its relatives by the characters appearing in italics above.

A specimen just received is as follows: 0.8 mile southwest of Cleveland, Liberty County, Texas, (east fork of San Jacinto River), *Shinners* 18330, April 8, 1954 (POM) (duplicated at Southern Methodist University). Moist bottomland woods.

Specimen examined.—Houma, Louisiana, Penfound, April 27, 1931 (NO).

Type collection.—Near l'Estancia de Suárez, Uruguay, *St. Hilaire*. "Inveni in paludosis propè praedium dictum *Estancia de Suarez*, haud longè à vico Sanctae-Lucia (provincia Cisplatina). Florebat Novembre."

30 *RANUNCULUS TRILOBUS* Desf. (Treatise:113)

Type collection.—Type (P—Desfontaine Herbarium), photograph (POM).

31 *RANUNCULUS MURICATUS* L. (Treatise:114)

Type collections.—(1) *R. muricatus*. The description was taken without change for Species Plantarum from Hortus Cliffortianus, but the specimen was not found in the Clifffort Herbarium (BM), in 1950. Consequently sheet number 66 in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype. (2) *R. echinatus*. Iso-type (G—"R. echinatus. n. sp. Bosc. Hort. Cels.") (3) *Var. carolinianus*. The DeCandolle Herbarium includes two Carolina specimens, one marked "ex herb. Ventenat," the other being designated here as a lectotype. Lectotype (G).

32 *RANUNCULUS ARVENSIS* L. (Treatise:115)

Additional specimens examined.—CALIFORNIA. MENDOCINO CO.: Potter Valley, Hoover 5035 (UC, POM). NORTH CAROLINA. MECKLENBERG CO.: Charlotte, Thorne & Muenscher 8047 (UC).

Type collection.—Specimen number 65 in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype. The Clifffort Herbarium specimen (BM), is not taken to be the type, because Linnaeus in Species Plantarum altered the Hortus Cliffortianus description by one word, changing the description for the leaves from "foliis decompositis linearibus" to "foliis superioribus decompositis linearibus." The specimen upon which the description in Hortus Cliffortianus was based has only dissected cauline leaves. Since only sheet 65 in the Linnaean Herbarium has basal leaves, it is evident that Linnaeus saw this specimen and presumably altered the description on the basis of the knowledge that the lower leaves were not dissected.

33 *RANUNCULUS NIVALIS* L. (Treatise:121)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 246.

Type collection.—(1) *R. nivalis*. Sheet number 38 in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype. The receptacle, as far as exposed, is glabrous, in distinction from *R. sulphureus*.

34 *RANUNCULUS SULPHUREUS* Solander (Treatise:122)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 247.

The statement of Sørensen that *R. nivalis* flowers earlier than *R. sulphureus* (Treatise:121) has been confirmed by field observation in Swedish Lapland and in the Pt. Barrow Region, Alaska.

The plants described by Hultén as var. *intercedens* (cf. p. 122) represent a minor taxon, which, although real, is based upon a single character. It is the preference of the writer not to assign such entities formal names but to describe and record them. The collections examined include the following from Alaska: Aleutian Islands, Rat Island, O. J. Murie 2332 (S); Atka, Eyerdam 1121 (S), 78 in 1932 (MIN), Hultén 6515b (S). In these specimens the basal leaves are deeply 3-parted. Basal leaves of the Kamchatka specimens are much less deeply so, being crenate as in the usual run of *R. sulphureus* but with two clefts.

Additional significant specimens.—ALASKA. Subarctic meadow, Mt. McKinley Park, Dutilly, O'Neill, & LePage 20,166, (POM); Craigie Creeks, Talkeetna Mountains, LePage 25,306 (POM).

35a *RANUNCULUS MACAULEYI* var. *MACAULEYI*, replacing var. *typicus* (Treatise:123)

Type collection.—The collection by Macauley in 1877 (GH) (cotype or under the 1950 Code, paratype) is designated as a lectotype.

36 *RANUNCULUS ESCHSCHOLTZII* Schlecht. (Treatise:124)

In northwestern Montana the varieties *Eschscholtzii* (cf. below), *Suksdorfii*, and *eximius* occur. On Mt. Clements and at Logan Pass in Glacier National Park the prevailing very common plant is var. *Eschscholtzii*. There are only a few small patches of var. *Suksdorfii* (L. Benson 5241 (POM-B) and field observation in 1949), and var. *eximius* has not been found. On Mt. Aenaeas in the Swan Mountains, Flathead County, all three varieties are represented in minor extremely localized populations. Most of these are internally variable and probably not of interest to apomixis detectives. On the north-facing slope east of the summit at 7,350 feet elevation is a population of var. *Eschscholtzii*, L. Benson 14017 (POM), showing a tendency toward the sharp leaf lobes of var. *Suksdorfii*, especially in L. Benson 14016 (POM). Var. *Suksdorfii* is represented clearly by a collection from the same place, L. Benson 14017b (POM). Var. *eximius* was not found in its extreme form, but forms combining its characters with those of var. *Suksdorfii* were abundant, suggesting that var. *eximius* has been genetically all but "swamped out" locally. Intermediate types are represented by plants found growing with those cited above (L. Benson 14017a (POM), 14017c (POM)) as well as in other places just north of

Mt. Aenaeas, where they are the prevailing type (points along the western knifedge rim of cirque, *L. Benson* 13989 (POM), 13989a (POM), 13996 (POM)). Intermediates between vars. *Eschscholtzii* and *Suksdorfii* were found also at points on the western rim of the cirque, *L. Benson* 13985 (POM). There are undistributed duplicates of most of these collections.

36a *RANUNCULUS ESCHSCHOLTZII* Schlecht. var. *ESCHSCHOLTZII*
replacing var. *typicus* (Treatise:126)

In the Aleutian Islands *R. Eschscholtzii* occurs at higher altitudes than most other *Ranunculi*, being restricted to areas about permanent snowbanks in the mountains, e.g. Adak, 2,000 feet elevation on Mt. Moffett, *L. Benson* 14,992 (POM, US, and duplicates). *R. occidentalis* var. *brevistylis*, an alpine and subalpine meadow plant, reaches its upper distributional limits at about this level; *R. Eschscholtzii* is at its lowest limit. The entire island is alpine in its flora, but *R. Eschscholtzii* is a representative of the extreme alpine flora of the island.

Type collections.—(1) *R. Eschscholtzii*. Since probably the type specimen was destroyed in the bombing of Germany in the Second World War, the following is designated as a neotype pending discovery of the type: "Ins. St. Georgii. Esch.," Hooker Herbarium (K). A specimen labelled from "Sinus St. Lorentii" is at Geneva. Although it is supposedly *R. Eschscholtzii*, the specimen is actually *R. nivalis*, and it is ruled out for consideration as part of Schlechtendal's original material. (3) *R. ocreatus*. Additional isotype, (MIN 113219).

Ranunculus Eschscholtzii var. *Hultenianus* var. nov.

Plant very slender, small but similar to var. *Eschscholtzii*; stems 4-8 cm. long, about 1 mm. in diameter; sepals 3-4 mm. long; petals 3.5-5 mm. long, scarcely exceeding the sepals, obovate.

Herba parva; caulibus 4-8 cm. longis, circa 1 mm. diametro; sepalis 3-4 mm. longis; petalis 3.5-5 mm. longis.

Kamchatka Peninsula and Bering Island, Siberia.

Specimens examined.—Ananna River, central Kamchatka, *Malaise* 195b, Sept. 5, 1926 (S) (type, cf. below); Kluschevskaja Volcano, *Malaise* in 1947 (S); Savoiko, Mt. Palovinja, southern Kamchatka, *Malaise* in 1928 (S), 3 sheets; Bering Island, *Ku'ajina* in 1928 (S).

Type collection.—"Kamtschatcka centralis: Ananna (Anauna or Anama?) River", *R. Malaise* 195b, Sept. 5, 1946 (S), the type mounted on two sheets. It is a pleasure to dedicate this variety to Dr. Eric Hultén, Director of the Naturhistoriska Riksmuseet, Stockholm, Sweden, and distinguished author of three floras covering Kamchatka, the Aleutian Islands, and Alaska and the Yukon. Dr. Hultén spent a considerable period in Siberia studying the flora of Kamchatka.

36b. *RANUNCULUS ESCHSCHOLTZII* var. *SUKSDORFII* (A. Gray) L. Benson
(Treatise:127)

Type collection.—Photograph (K) probably of the type (GH).

36c *RANUNCULUS ESCHSCHOLTZII* var. *EXIMIUS* (Greene) L. Benson
(Treatise:128)

Type collections.—(1) *R. eximius*. Additional isotypes, (MIN 113765 and 113768). (2) *R. saxicola*. Additional isotypes, F 81421, MIN 114494).

36d *RANUNCULUS* ESCHSCHOLTZII var. *TRISECTUS* (Eastw.) L. Benson
(Treatise:128)

Additional significant specimens.—IDAHO. IDAHO CO.: Dry Diggins, Seven Devils Mountains, St. John & Mullen 8533 (UC (ex WSC)).

Type collection.—Additional isotype (MIN 113220).

36e *RANUNCULUS* ESCHSCHOLTZII var. *OXYNOTUS* (A. Gray) Jepson
(Treatise:129)

Type collection.—Isotypes (K, P, F 207740).

37a *RANUNCULUS* ADONEUS var. *ADONEUS*, replacing var. *typicus*
(Treatise:130)

Type collection.—Since "cotype" has no official status under the International Rules of Botanical Nomenclature adopted at Stockholm in 1950, *Parry* 81 in 1861 (GH) is designated as a lectotype. According to the International Code of Botanical Nomenclature (1952), article 18, note 3, p. 18, "When two or more specimens have been designated as types by the author of a name (e.g. male and female, flowering and fruiting, etc.) one of them must be chosen as a lectotype." Isotypes as cited previously, the collections being those clearly designated as *Parry* 81 in 1861; additional isotypes (P, K).

39 *RANUNCULUS* GELIDUS Kar. & Kir. (Treatise:132)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 248.

Additional specimens examined.—ALASKA. Popof Island, Shumigan Islands, Kincaid in 1899, add (G, K). COLORADO. Gravelly places, mountains north of Trenton, 12-13,000 ft., C. A. Purpus in 1892-3 (P). CLEAR CREEK CO.: Trail from Steven's Mine to the summit of Gray's Peak, *Weber* 5620 (POM). PARK CO.: Upper northeast slope of Mt. Lincoln, 13,400 feet, *Penland* 4257 (POM).

Type collection.—(1) *R. gelidus*. Isotype (G). (2) *R. Hookeri*. Type (K).

40a *RANUNCULUS* PYGMAEUS var. *PYGMAEUS*, replacing var. *typicus*
(Treatise:134)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 249.

Additional significant specimens.—ALBERTA. Lake O'Hara, *Butters & Holway* 147 in 1907 (MIN). MONTANA. BEAVERHEAD CO.: Top of Torrey Peak, Pioneer Range, *Hitchcock & Muhlück* 15043 (UC). COLORADO. BOULDER CO.: Long's Peak, *Kiener* 5374 (POM). LARIMER CO.: Cony Lake, *Kiener* 832 (POM). CLEAR CREEK CO.: North slope of Gray's Peak (rare), *Weber* 5611 (POM), 5620 (MIN).

Type collections.—Probable isotype, J. E. Smith Herbarium (987.51), Linnaean Society, London.

40b *RANUNCULUS* PYGMAEUS var. *LANGIANUS* (not *Langiana*) Nathorst
(Treatise:135)

In early botanical literature, it was the custom of at least some authors to consider all varieties as feminine. Marcel Raymond has pointed out to the writer the desirability of emending varietal epithets of this sort.

Type collections.—(2) Var. *petiolulatus*. Additional isotype (MIN 114378).

41 *RANUNCULUS* SABINEI R. Br. (Treatise:136)

See the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 250.

42 *RANUNCULUS ALLENII* Rob. (Treatise:137)

Type collections.—Additional isotypes (K, P, MIN 113416).

43a *RANUNCULUS INAMOENUS* var. *INAMOENUS*, replacing var. *typicus* (Treatise:138)

Additional synonym.—*R. inamoenus* var. *elatior* Boivin, Can. Field. Nat. 65:4. 1951.

Plants of this species were found flowering in the fall of 1950, as follows: COLORADO. SAN JUAN CO.: North of Silverton, *L. Benson* 14747, Oct. 30, 1950 (POM). NEW MEXICO. SANDOVAL CO.: Aspengrove on road to Sandia Crest, *L. Benson* 14670, Oct. 23, 1950 (POM). This collection has cordate to subcordate basal leaves. This character occurred in every plant in the vicinity, but in cultivation side by side in flower pots at Claremont, California, the plants of numbers 14670 and 14747 have identical leaves. Both collections flowered and fruited continuously for a year.

Additional significant specimen.—WASHINGTON. STEVENS CO.: (?). Mountain valleys near Kettle Falls, on the Columbia, *Douglas* in 1826 (BM). IDAHO. BLAINE CO.: *Galena*, *L. Benson* 12934 (POM).

Type collections.—(1) Var. *apetalus*. The following is designated as a lectotype: "R. affinis β apetalus. Dry mountain prairies, *Drummond*" (K). (3) Var. *micropetalus*. Additional isotype (K). (5) Var. *elatior*, "SASKATCHEWAN, MAPLE CREEK DISTRICT, CYPRESS HILLS PARK: A. J. *Breitung* 4406, in a ravine, July 7, 1947 (DAO Type, SASKU, SWC, isotypes) . . ." Type (DAO), isotype (SWC). The plant at the left on the type sheet may be *R. pedatifidus* var. *affinis* or perhaps *R. cardiophyllus* or a hybrid; that at the right is *R. inamoenus* var. *inamoenus*. The identity of the plant at the left can not be determined for certain because there are no petals or basal leaves. Var. *elatior* is taken to have been based upon the plant at the right, which agrees clearly with the other specimens cited.

44 *RANUNCULUS RHOMBOIDEUS* Goldie. (Treatise:142)

Additional significant specimen.—WASHINGTON or IDAHO. Spokane River, *Douglas* (K).

Some plants from North Dakota to Wisconsin are large: stems up to 4.5 dm. tall and 6 mm. in diameter; leaves up to 7.5 cm. long and 6 cm. broad.

Type collections.—(2) *R. rhomboideus*. Isotype (K). (3) *R. brevicaulis*. Paratypes should be found at Kew, but none were recorded in 1950; consequently selection of a lectotype is postponed. Duplicates of the two paratypes mounted on the same sheet (BM); probable duplicate of one (G) ("Flor. Bor. Am.").

45b *RANUNCULUS FORRERI* var. *FORRERI*, replacing var. *typicus* (Treatise:144)

Type collections.—(2) *R. pentadontus*. Additional isotypes (K, S).

Additional specimen examined.—Cerro Prieto, 20 airline miles west of Otinapa, Durango, *Maysilles* 7347 (MICH). The petals are up to 14 mm. long and 10 mm. broad.

45b *RANUNCULUS FORRERI* var. *MADRENSIS* (Rose) *L. Benson* (Treatise:144)

Type collections.—Additional isotype (K).

46a *RANUNCULUS GENTRYANUS* var. *GENTRYANUS*, replacing var. *typicus* (Treatise:145)46b *RANUNCULUS GENTRYANUS* var. *PALMERI* *L. Benson* (Treatise:146)

This plant, known previously only from the type collection by Palmer in 1906, now can be understood because of collections in Durango in 1950 by

James H. Maysilles, as follows: 5 miles north of railroad at Coyotes (45 airline miles west of Durango), grassland and oak-pine woodland, 2,400-2,500 m., *Maysilles* 7135 (POM), 7143 (POM). Varietal status under *R. Gentryanus* L. Benson is indicated to be correct by the collection of a plant from a variable and obviously transitional population: San Luis, 70 airline miles west of Durango, *Maysilles* 7209 (POM). Basal leaf blades up to 8.5 cm. long and 4 cm. broad; bracts deeply parted, the divisions linear; petals up to 3 cm. broad; achenes about 1.5 mm. in diameter, finely and softly pubescent; receptacle pubescent. The flowers are much smaller and the petals more slender than those of the related *R. Forsteri*; the achenes are fewer; the leaves are proportionately much broader.

47a *RANUNCULUS ARIZONICUS* var. *ARIZONICUS*, replacing var. *typicus* (Treatise:147)

Type collections.—(1) *R. arizonicus*. The following collection is designated as a lectotype: ARIZONA. COCHISE CO.: Rucker Valley, Chiricahua Mts, J. G. Lemmon 585, September 28, 1881 (GH), photograph (POM-B). Isotype (UC 118259). (2) *R. nudatus*. Additional isotypes (G, BM, K, P, MIN 114157).

48a *RANUNCULUS CARDIOPHYLLUS* var. *CARDIOPHYLLUS*, replacing var. *typicus* (Treatise:148)

Additional significant specimen.—WASHINGTON. STEVENS CO.: (?). Mountains near the Kettle Falls, Douglas (BM), bearing apparent type label of *R. glaberrimus* and labelled as that species. Obviously the locality may not be correct.

Type collection.—(1) *R. cardiophyllus*. The collection by Drummond at Kew is particularly good material. It is designated as a lectotype. Unfortunately, if there is an indication of the place of collection, this was not recorded. Specimen labelled "Fl. Bor. Am." (G). (4) Var. *pinetorum*. Additional isotypes (BM, G, F 122819).

48b *RANUNCULUS CARDIOPHYLLUS* var. *SUBSAGITTATUS* (A. Gray)
L. Benson (Treatise:149)

Type collections.—Probable additional isotypes, (although the collector's name is not given, almost certainly it was J. G. Lemmon) (BM), Aug., 1884, Mt. San Francisco (BM), Aug. and Sept., 1884, Mt. San Francisco (P) ("Wet meadows, San Francisco Mts. N. Ariz").

50a *RANUNCULUS AURICOMUS* var. *AURICOMUS*, replacing var. *typicus* (Treatise: 151)

European authors have described recently a number of "microspecies" based upon apomictic races of this species, and at least 200 more are in prospect. This is representative of the policy of considering any two plants incapable of interbreeding to be separate species, regardless of other factors. Organization of the world's plant species upon such a basis would involve multiplying their numbers by infinity.

Type collections.—The specimens in the Linnaean Herbarium, Linnaean Society, London, are incomplete, sheet number 21 having only the top leaves and sheet 22 being a young plant with no flowers. Therefore, the sheet in the Clifford Herbarium is designated as a lectotype (BM).

51 *RANUNCULUS PEDATIFIDUS* J. E. Smith (Treatise:152)

51a *RANUNCULUS PEDATIFIDUS* var. *PEDATIFIDUS*

R. pedatifidus J. E. Smith in Rees, Cyclop. 29: *Ranunculus* sp. no. 72. 1819. *R. affinis* R. Br. var. *leiocarpa* Trautv. Middendorf's Reise 1:62. 1847. (?) *R. verticillatus*

Eastw. Bot. Gaz. 33:144 f. 3. 1902. *R. pedatifidus* var. *leiocarpus* Fern. Rhodora 19:138. 1917.

Plant small, slender, and delicate in appearance; roots filiform; stems 1-2 dm. long, 1-2 mm. in diameter; basal leaves orbicular in outline, 1.5-2.5 cm. in diameter, deeply cordate basally, finely dissected into very narrowly linear segments, the larger ones 1.5-2.5 mm. broad.

Meadows and moist woods of the mountains and the subarctic or arctic coasts; Arctic Tundra and Asiatic northern and mountain forests. Central Asia to the Bering Sea region. Probably occasional on the Alaskan side of Bering Sea.

Specimens examined.—SIBERIA or ALASKA. *Arakamtchetchene* Island, Bering Strait, C. Wright in 1853-6 (Herbarium of the United States North Pacific Exploring Expedition under Commanders Ringgold and Rodgers) (K, P, US). ALASKA. Nome (Cape Nome on the label), *Blaisdell* in 1900 (CAS), photograph (POMB, NY, US, GH); Nome J. P. Anderson 3192 (ISC), 3794 (ISC). Reference of these incomplete collections (and with them the epithet *verticillatus*) to var. *pedatifidus* is open to question. The problem of occurrence of var. *pedatifidus* in North America requires field study in the vicinity of Nome and elsewhere along the Bering Sea.

Type collections.—(1) *R. pedatifidus*. (Cf. Treatise:153). In 1950, the writer found two sheets of *R. pedatifidus* in the Linnaean Herbarium, Linnaean Society of London, numbers 62 and 63. These plants, marked "Siberia [eastern Siberia]," are designated as a lectotype. The nectary scale in each of these forms a pocket, as is usual in the section *Epirotes*. The distal margins of the scale are somewhat prolonged, making the upper corners of the pocket pointed. (2) Var. *leiocarpa*, cf. Treatise:153. The writer has not seen this Asiatic type, and application of this epithet is uncertain. Fernald applied it simply to plants having glabrous fruits, regardless of other characters. (3) *R. verticillatus*. cf. Treatise:153.

51b *Ranunculus pedatifidus* var. *affinis* (R. Br.) comb. nov.

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 251.

R. affinis R. Br. Bot. App. Parry's 1st Voy. 265. 1823. *R. arcticus* Richards. in Frankl. 1st. Jour. Bot. App. ed. 1. 741. 1823. *R. vicinalis* Greene, Pittonia 4: 145. 1900. *R. apetalus* Farr, Ottawa Nat. 20:110. 1906, not *R. affinis* var. *apetalus* D. Don in 1831. *R. pedatifidus* var. *cardiophyllus* f. *apetalus* Boiv. Can. Field. Nat. 65:4. 1951.

Plants larger and more robust than in var. *pedatifidus*; roots 0.6-1 mm. in diameter; stems 2-4 dm. long, 2-3 or 4 mm. in diameter, somewhat fistulose; basal leaves cordate to cordate-orbicular in outline, 1.5-3.5 cm. long, 1.5-3 or 4 cm. broad, fewer times dissected than in var. *pedatifidus*, pedately divided or parted into 5-7 linear divisions some of which are again lobed, the blade proximally cordate, the divisions linear but much broader than in var. *pedatifidus*.

Meadows, tundra, woods, and plains at elevations of 2,500 to 5,000 feet in Alberta or up to 9,000 feet in the southern Rocky Mountains; Arctic and West American Alpine Tundra, Northern Forest, and Rocky Mountain Forests. Alaska to the Canadian Arctic islands, Labrador, Newfoundland, and Greenland and southward to Alberta and Saskatchewan; Columbia Falls, Montana; Gaspé Peninsula, Quebec; Wyoming and Colorado; in modified form (cf. Treatise:152-3) in Utah and northern Arizona.

Type collections.—(Cf. Treatise:153). (1) *R. affinis*. At Kew only the collections by Ross and Sabine were found in 1950. A plant (987.28) in the Herbarium of J. E. Smith, Linnaean Society, London, is labelled "Melville Isld.—Hort. Soc. 1824;" (2) *R. arcticus*. Type (K). (3) *R. vicinalis*, cf. Treatise:153. (4) *R. apetalus*, cf. Treatise:153.

53 *RANUNCULUS MONTIGENITUS* L. Benson (Treatise:156)

This is represented by authentic material (Townsend & Barber 42) in European herbaria (BM, K, P, G).

54a *RANUNCULUS PERUVIANUS* var. *PERUVIANUS*, replacing var. *typicus* (Treatise:157)

Type collection.—Type (P—Herbarium of Jussieu).

Additional significant specimens.—MEXICO. NUEVO LEON. Ojo de Agua, 6,600 ft., foot of Cerro Potosi, Sharp 45729 in 1945 (POM, TENN); near top of Cerro Potosi, 11,000 ft., Sharp 45739 in 1945 (TENN, POM); Cerro Linadero, Dulces Nombres (and just east of the border into TAMAULIPAS), Meyer & Rogers 2921 (POM).

55a *RANUNCULUS HARVEYI* var. *HARVEYI*, replacing var. *typicus* (Treatise:159)

Type collections.—(1) *R. Harveyi*. The two cotypes (syntypes under the 1952 Code) by Harvey and Hasse (cf. Treatise:159) are mounted on a single sheet (GH). The collection by Harvey is designated as a lectotype; the other then becomes a paratype. (3) var. *pilosus*. Type (F 580710).

56 *RANUNCULUS ALLEGHENIENSIS* Britt. (Treatise:160)

Additional significant specimens.—TENNESSEE. HAYWOOD CO.: East prong of Den Branch, Cataloochee District, Jennison 3742 (TENN). CARTER CO.: Riphshin Camp, Cain & Duncan 199-2 in 1934 (TENN). Camp Nelson, Ripshen (same as Riphshin?), Cain, Duncan, & Sharp 601, in 1934 (TENN).

57 *RANUNCULUS MICRANTHUS* Nutt. (Treatise:161)

Additional synonyms omitted accidentally.—*R. micranthus* var. *cymbalistes* (Greene) Fern. Rhodora 41:543. 1939. *R. micranthus* var. *delitescens* (Greene) Fern., loc. cit. This segregation can not be evaluated fully without further field study.

58a *RANUNCULUS ABORTIVUS* var. *ABORTIVUS*, replacing var. *typicus* (Treatise:162)

Spelling variant.—*Ranunculus aborticus* Poir. in Lam. Encyc. Meth. 6:109. 1804.

Additional significant specimen.—ALASKA. Homer, Kenai Peninsula, LePage 25232 (POM).

Type collections.—(1) *R. abortivus*. At the British Museum of Natural History a sheet is labelled, "Virginia, Clayton" (mixed with *R. recurvatus*). The Linnaean Herbarium, Linnaean Society, London, has a good specimen from Kalm, sheet number 26 (no collection data). Another sheet from Kalm labelled "14. *R. abortivus*" is in the Linnaean Herbarium at the Naturhistoriska Riksmuseum, Stockholm. The Kalm specimen in the Linnaean Herbarium, Linnaean Society of London is designated as a lectotype; presumably that at Stockholm is an isotype (i.e., in this case a duplicate of the lectotype). Another collection is at Geneva, "*R. nemorosus*, vel sylvaticus Virginianus flore parvo, molliori folio . . . [balance illegible]." (2) *R. nitidus*. Probable isotype, "Caroline, Bosc" (G). (5) *R. Holmei*. A collection by Greene was designated in 1941 by the writer as a lectotype because no collections by Holm were found in the Herbarium Greceanum. Although this decision must stand, the following collection is to be noted: "In repibus humidis ad flumen Potomac, hive inde, 4. 1900, Washington", D. C., Th. Holm (S).

58c *RANUNCULUS ABORTIVUS* var. *INDIVISUS* Fern. (Treatise:165)

Type collections.—Additional isotypes (K, BM).

59 *RANUNCULUS DONIANUS* Pritzel (Treatise:165)

Type collections.—(1) *R. humilis*. Additional isotypes (G). ("*Ranunculus nova*. Moc. et Sesse). Pavon. Mexique." (2) *R. Donianus*. Same type.

60 RANUNCULUS JOVIS A. Nels. (Treatise:166)

Type collections.—(1) *R. digitatus*. Type (K).

61 RANUNCULUS GLABERRIMUS var. GLABERRIMUS, replacing var. *typicus* (Treatise:167)

Type collections.—(1) *R. glaberrimus*. Type (K—Hooker Herbarium) ("Open pine woods near Kettle Falls on the Columbia. 1826, Douglas"); isotype (K—Bentham Herbarium) (BM) ("Open pine woods near the Kettle Falls on the Columbia, Apr. 1826"). Another specimen (BM) bears a label indicating data expected for the type of *R. glaberrimus*, and it is labelled as that species. However, this plant is *R. cardiophyllus*. (2) *R. Austinae*. Through the kindness of Drs. John D. Mizelle and Albert L. Delisle, the Herbarium Greeneanum has been rechecked for the type specimen, and it has not been found there. Pending its discovery, US 1466016 is designated as a lectotype. It is possible either that the collection in the Greene Herbarium may have been left at the National Herbarium after Greene's stay there or that Greene studied the specimen in the National Herbarium rather than his own. Additional isotypes (BM, S). It should be noted that this is not *Beckwithia Austinae* Jepson, a synonym for 87 *Ranunculus Andersonii* A. Gray.

61b RANUNCULUS GLABERRIMUS var. ELLIPTICUS Greene (Treatise: 168)

Additional synonyms.—*R. Buddii* Boivin, Can. Field. Nat. 65:3 unnumbered pl. 1951. *R. Buddii* f. *monochlamydeus* Boivin, loc. cit.

Additional significant specimens.—SASKATCHEWAN. Coulee, Cadillac Res. Area. E. W. T. (SWC); Shallow Coulee, Swift Current, J. L. Bolton & A. C. Budd, May 5, 1937 (SWC), and May 12, 1942 (SWC); Bank of shallow coulee, Budd 258, April 29, 1947 (SWC). The paratype in Boivin's photograph is a duplicate of the last collection cited above. Both Budd 255 and Budd 258 are duplicated by an apetalous form (SWC). An apetalous form occurs in var. *glaberrimus* (cf. Treatise:168). This feature is found in several species of *Ranunculus*.

A specimen collected in New Mexico and purportedly duplicating one cited under this species (Treatise:170) (NEW MEXICO. RIO ARRIBA CO.: Eggleston 6459 (S)) is *Ranunculus oreogenes* Greene. It is likely that the duplicates of this number (NY, GH) and the other collection from New Mexico (RIO ARRIBA CO.: Willow Creek, Eggleston 6483 (NY)) are the same species because northern New Mexico is out of the probable range for var. *ellipticus* but near the range of *R. oreogenes*. The plants were examined before *R. oreogenes* was distinguished as a taxon and when it was known to exist only from the type specimen, which was misinterpreted. Other collections, recent and old, have come to light since.

Type collections.—(3) *R. Buddii*, "SASKATCHEWAN: A. C. Budd, Swift Current, moist prairie, May 8, 1936 (DAO type): Isotype SWC." (4) *F. monochlamydeus*, "SASKATCHEWAN: A. C. Budd, Consul, low areas on bench land, April 29, 1947 (DAO type)." The apetalous form of Budd 258 cited in the second paragraph above is an isotype (SWC).

61c RANUNCULUS GLABERRIMUS var. RECONDITUS (Nels. & Macbr.)
L. Benson (Treatise:169)

It is to be noted that publication of *R. reconditus* was superfluous because *R. triternatus* Poir., in Lam. Encyc. Meth. Suppl. 4:662. 1816, was cited merely as a synonym for his nomen novum *R. Commersonii* based upon *R. biter-natus* J. E. Smith, Rees, Cyclop. 29: (pages not numbered; *Ranunculus* under *R*), Sp. No. 48. 1819 (1813-16?). The epithet *triternatus* was a misspelling. The writer regrets not having chosen in 1936 to use *triternatus* in varietal rank, but no change is possible.

Additional significant specimen.—SOUTH DAKOTA. "Stutzman Co. and westward to the Missouri River," Leiberg in 1883 (MIN).

Type collections.—(1) *R. triernatus*. (All listed in Treatise). Additional isotypes (P, K). (2) *R. reconditus* nom. nov. for *R. triernatus* A. Gray.

62 *RANUNCULUS OROGENES* Greene (Treatise:172)

Cf. note under *R. glaberrimus* var. *ellipticus* concerning occurrence of this species in Rio Arriba County, New Mexico.

Type collection.—Additional isotype (MIN 113408).

63a *RANUNCULUS ALISMAEFOLIUS* var. *ALISMAEFOLIUS*, replacing var. *typicus* (Treatise:174)

Type collections.—(1) *R. alismaefolius*. Type (K); additional isotypes (BM, G). A plant at Paris is labelled "Oregon," which at the time of collection indicated the entire Pacific Northwest. It may be an isotype (P).

63b *RANUNCULUS ALISMAEFOLIUS* var. *HARTWEGII* (Greene) Jepson (Treatise:177)

Type collections.—(1) Var. *caule petiolisque basi hirsutis*. Type (K—Bentham Herbarium) (bases of the stems markedly hirsute, but the petioles only slightly so, the plant tending toward var. *Lemmonii*); additional isotypes (BM, G) (stem base hirsute, petioles glabrous).

63c *RANUNCULUS ALISMAEFOLIUS* var. *LEMMONII* (A. Gray) L. Benson (Treatise:178)

Type collections.—Apparent isotype (G) (but the plant is var. *Hartwegii* with rather long petals). Confusion of the materials distributed as the type collection is common because four species were included.

63d *RANUNCULUS ALISMAEFOLIUS* var. *DAVISH* L. Benson (Treatise:179)

Additional significant specimens.—MONTANA. Granite, Kelsey in 1892 (OB). IDAHO. The population is well defined as shown by field observation and the following specimens listed below. There is some variation, however, in degree of hirsuteness of the petioles and stem bases. ADAMS CO.: 2 miles west of New Meadows, L. Benson 13765 (POM); Adams County just west of the Valley County line west of Payette Lake, L. Benson 13850 (POM); VALLEY CO.: Junction of the road around Big Payette Lake with new road to the South Fork of Salmon River, L. Benson 13808 (POM); north side of Lick Creek Summit, 6,500 feet, L. Benson 13813 (POM); Lick Creek Summit, 6,900 feet, L. Benson 13825 (POM) (plants generally glabrous); west of Lick Creek Summit, 6,200 feet, L. Benson 13831 (POM). Each of the Idaho specimens cited is duplicated.

63e *RANUNCULUS ALISMAEFOLIUS* var. *ALISMELLUS* A. Gray (Treatise:180)

Type collections.—Additional isotype (K); additional paratype (K).

63f *RANUNCULUS ALISMAEFOLIUS* var. *MONTANUS* S. Wats. (Treatise:181)

Type collections.—(3) *R. unguiculatus*. Additional isotypes (G, BM, K).

64 *RANUNCULUS ORESTERUS* L. Benson (Treatise:182)

It is to be noted that this rare species was collected by Nuttall (P) (part of collection from Rocky Mountains and Oregon, labelled as *R. glaberrimus*).

Type collection.—Additional isotype (P).

65 *RANUNCULUS AMBIGENS* S. Wats. (Treatise:183)

Additional synonym.—*R. flammuloides* Raf. ex DC. Prodr. 1:32. 1824, as syn., nom. nud.

Type collection.—(2) *R. flammuloides*. None given. Isotype (G) ("167 *Ranunculus flammuloides* Raf. 1802. *R. flammula* Am. bot. sed diversus. Missouri (?) E." Delessert Herbarium (*R. Flammula* folder). (3) *R. ambiguus*:* "*R. Flammula*. Pursh 391; not DC. Richards. in Frankl. Journ. 13. Hook. Fl. Bor.-Am. 1.11, in part. Torr. & Gray Fl. 1.16. Torr. Fl. N. Y. 1.11. Gray *Manual*, 1 ed. 8. Lawson, *Ranunc. Canad.* 40. Wood, Bot. & Fl. 19. **R. lingua*. Pursh, 391. Torrey, *Compend.* 225. Don, *Mill.* 1.31, in part. *R. Robini*. Raf. Fl. Lud. 82. Seringe, *Melange Bot.* 70, plant unknown. **R. alismaefolius*. Benth., l.c., in part. Gray, *Manual*, 41 (2 ed. 8). Chapman, 7." Although the 1878 publication is valid through reference to earlier descriptions, later Watson, *Proc. Amer. Acad.* 14:289. 1879, supplied his own description of *R. ambiguus* accompanied by selected references, i.e. to "*R. alismaefolius*, Benth. Pl. Hartw. 295, as to the eastern plant, and Gray, *Manual*, 41 [the 5th edition extant at the time]." The "eastern plant" of Bentham was based upon a reference to "... Torr. & Gray, Fl. N. Amer. 1. p. 16, non. Lin. nec. auct. plur. . . ." The reference to Gray's *Manual*, page 41, applies, as indicated by Watson in 1878, also to page 8 of the second edition. A specimen in the Gray Herbarium collected by Oakes at York, Maine, is labelled "*R. alismaefolius* Geyer, *Manual* 2" in Gray's handwriting. According to the first edition of Gray's *Manual* (preface x. 1848) specimens supplied by Oakes were used in preparation of the *Manual*. The specimen by Oakes (mounted on two sheets) is designated as a lectotype of *R. ambiguus*. Lectotype (GH). Three specimens collected by Wright at Wethersfield, Connecticut, and labelled probably in Watson's handwriting are ruled out as possible lectotypes because they were collected in 1878 and 1879, undoubtedly too late to have been on hand before preparation of the Bibliographic Index to North American Botany published in March, 1878.

66a *RANUNCULUS FLAMMULA* var. *FLAMMULA*, replacing var. *genuinus* (Treatise:185)

Type collections.—Sheet number 1 in the Linnaean Herbarium, Linnaean Society, London, is designated as a lectotype. The toothing of the leaves is not extreme.

66b *RANUNCULUS FLAMMULA* var. *OVALIS* (Bigel.) L. Benson (Treatise:186)

Additional synonym.—*R. reptans* L. var. *erectus* Victorin & Rousseau, *Contr. Inst. Bot. Univ. Montreal* (36):16. 1940.

Type collections.—(1) Var. *ovalis*. Collection by Bigelow labelled "14. Bogs" (P). However, since the plant is labelled "*R. filiformis* Mx.," probably it is not an isotype of var. *ovalis*. (6) Var. *erectus*. (Cf. data in Treatise:188). Type: mounted on four sheets, University of Montreal; isotype (POM 278442) (specimen furnished through the courtesy of Dr. Ernest Rouleau). The stoloniferous habit of the plant is shown by another collection, a topotype (Victorin, Germain, & Dominique 49536, *University of Montreal*).

66c *RANUNCULUS FLAMMULA* L. var. *FILIFORMIS* (Michx.) Hook. (Treatise:188)

See the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 252.

Type collections.—(1) *R. reptans*. Sheet number 2 in the Linnaean Herbarium, Linnaean Society, London, is designated as a lectotype. The leaves are up to 15 mm. long and 1.5 mm. broad. (2) *R. filiformis*. Type (P—Michaux Herbarium) photograph (POM); isotype (P—General Herbarium).

67a *RANUNCULUS HYDROCHAROIDES* var. *HYDROCHAROIDES*, replacing var. *typicus* (Treatise:190)

Type collection.—Additional isotype (K).

* The original was divided into paragraphs at the points indicated by the asterisks.

67c *RANUNCULUS HYDROCHAROIDES* var. *NATANS* (Nees) L. Benson
(Treatise:191)

Type collections.—(2) *R. vagans*. Additional isotypes (G, P, BM, S, OB). (4) *R. Sessei*. Type (G).

69 *RANUNCULUS POPULAGO* Greene (Treatise:193)

Significant specimen.—MONTANA. Hunter Mountain, Bitterroot Range, Underhill in 1948 (POM).

Type collections.—Additional isotype of both *R. Populago* and *R. Cusickii* (K).

70 *RANUNCULUS LAXICAULIS* Darby, replacing *R. texensis*
(Treatise:194)

Haskell Venard, *Rhodora* 51:164-6. 1949, has shown that *R. laxicaulis* has priority over *R. texensis* (1845) because it was published first by Darby at an earlier date than that of his *Botany of the Southern States* (1855). Mr. Vernard and Dr. Wilbur H. Duncan of the University of Georgia have been very kind in supplying the writer with a typewritten transcript of the treatment of *Ranunculus* in Darby's earlier publication, *A Manual of Botany Adapted to the Productions of the Southern States, Part I. Vegetable Anatomy and Physiology, Part II.* 4-6. 1841 (perhaps actually 1842). *R. laxicaulis* is described on page 4. There is no reference to earlier publication of the epithet in varietal status by Torrey and Gray and only the following statement, "Ditches. Car. and Geo. July." Reference to Torrey and Gray is through only the later work by Darby (1855). (2) Var. *denticulatus*. Additional isotypes (BM, K).

71a *RANUNCULUS PUSILLUS* var. *PUSILLUS*, replacing var. *typicus*
(Treatise:197)

Type collections.—(1) *R. pusillus*. The following four sheets at Geneva are probably a single collection. The third mentioned is designated as a lectotype (G): "Carol. Bosc" (DeCandolle Herbarium); "Cor - - des fontaines, Caroline, Bosc" (DeCandolle Herbarium), "fontaines de Caroline, Bosc" (General Herbarium, the lectotype), and "Caroline Bosc" (Delessert Herbarium). A specimen at Paris may be part of the type collection. It is labelled "Caroline."

71b *RANUNCULUS PUSILLUS* var. *ANGUSTIFOLIUS* (Engelm.)
L. Benson (Treatise:197)

Type collections.—(1) *R. trachyspermus*. Additional isotypes (BM, K). (2) Var. *angustifolius*. Additional isotypes (BM, K).

72a *RANUNCULUS BONARIENSIS* Poir. var. *TRISEPALUS* (Gill.) Lourteig,
Darwiniana 9:465. f. 19. 1951, replacing *R. alveolatus* Carter

Additional synonym.—*Ranunculus trisepalus* Gill. ex Hook & Arn. Bot. Misc. 3:133. 1834.

This species is clearly in the largely South American group of *Ranunculi* of the Section *Flammula* having 3 sepals, as is *R. flagelliformis*. Its relationship to *R. pusillus* is not as close as supposed previously (cf. *R. alveolatus*, Treatise).

At Paris and in London in 1950, the writer noted the identity of the Californian plant described recently as *R. alveolatus* with the South American *R. trisepalus*, which earlier Dr. Lourteig had indicated to be a proposed variety of *Ranunculus bonariensis*. Photographs of both the lectotype designated below and other specimens on the same herbarium sheet and of those at Paris were secured. Examination of series of specimens fails to reveal any differences

between the Californian plants and those growing in Chile and Argentina. The variety occurs in South America and is in proximity to three other varieties of the same species. Although there is a slight possibility that the Californian plants were introduced from Chile, it is not likely that the species has been transported from one place to the other. The disjunct area in California was not occupied to any extent by early Spanish-American settlers, and it is distant from the populous areas about seaports. The variety occurs only in the Sacramento and San Joaquin valleys and the adjacent lower foothills of the Sierra Nevada. This extreme disjunct distribution of species or vicarious species or varieties occurring in California and southern South America (especially Chile) represents a surprisingly frequent pattern.

Additional specimens examined.—CALIFORNIA. SUTTER CO.: Pleasant Grove, Hoover 1147 (UC). MERCED CO.: 7 miles north of Merced, Hoover 2075 (UC).

Type collections.—(1) *R. trisepalus*, (Herb. Hookerianum) ("[Meadows near] Buenos Ayres, [1820]. J. Gillies, Valparaiso, Cuming (No. 706.)" (specimens mounted on the same sheet), photographs (POM) (Courtesy of Dr. F. G. Meyer, Missouri Botanical Garden) (MO). The collection by Cuming is designated as a lectotype (K). (2) *R. alveolatus*. Additional isotypes (BM, OB, F 1072022, MIN 359439).

73 *RANUNCULUS FLAGELLIFORMIS* J. E. Smith (Treatise:199)

Several collections from Costa Rica (cf. Treatise) represent robust plants with large, toothed leaves. Although these seem to be *R. flagelliformis*, it is possible that they constitute a local variety of the species. Only a few South American collections approach them.

Type collections.—The following specimen is designated as a lectotype: J. E. Smith Herbarium, Linnaean Society of London, (sheet 987.28). Note: A plant at Paris is marked as follows: Type of *Casalea flagelliformis* St. Hil. "Bresil.—Province de Saint-Paul. Voyage d' Auguste de Sainte-Hilaire, de 1816 a 1821. Catal. C¹, No. 1081." It is *R. flagelliformis*.

74 *RANUNCULUS HYPERBOREUS* Rottb. (Treatise:201)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 253.

Additional synonyms.—*R. hyperboreus* f. *Turquetilianus*, Savile & Calder, Can. Field Nat. 66:105. 1952. *R. hyperboreus* f. *integrescens*, Savile & Calder, loc. cit.

Additional specimen examined.—(The form described as var. *Turquetilianus*.) KEELWATIN: Chesterfield Inlet near Mission, Saville & Watts 1329 (POM).

Type collections.—(5) f. *integrescens*, "At edge of muck pool 8 mi. south of Chesterfield Inlet, Keewatin, 16 Aug. 1950, D.B.O. Savile (1464) and C. T. Watts (TYPE)." Isotype (POM 279377).

75a *RANUNCULUS NATANS* var. *NATANS*, replacing var. *typicus* (Treatise:202)

76a *RANUNCULUS SCCLERATUS* var. *SCCLERATUS*, replacing var. *typicus* (Treatise:203)

Type collections.—Type, Clifford Herbarium (BM), the description of the species having been taken without change by Linnaeus for Species Plantarum from Hortus Clifortianus. This specimen is designated as a lectotype.

76b *RANUNCULUS SCCLERATUS* var. *MULTIFIDUS* Nutt. (Treatise:204)

Type collections.—(1) Var. *multifidus*. Type (BM). (2) *R. eremogenes*, the type of var. *multifidus* above, is designated as a lectotype of *R. eremogenes*. (3) Var. *degener*. Additional isotype (F 122821). (4) Var. *pilosulus*. Additional isotypes (G, K. MIN

113763). (5) Var. *pubescens*. The following specimen is designated as a lectotype: NORTH DAKOTA. BENSON CO.: Around slough, Leeds, J. Lunell 17, June 7, 1912 (MIN 257623).

77a *RANUNCULUS GMELINII* var. *GMELINII*, replacing var. *typicus*
(Treatise:206)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 253.

Type collections.—(1) *R. Gmelinii*. In 1950 no specimen was found in the DeCandolle Herbarium (G). Sheet number 46 in the Linnaean Herbarium, London, almost certainly an isotype, is designated as a lectotype. It is labelled on the back, "*Ranunculus foliis duplicato, 3-fidis, caulibus filiformis declinatis. Gmel.*"

77b *RANUNCULUS GMELINII* var. *LIMOSUS* (Nutt.) Hara
(Treatise:208)

Type collections.—Type (BM—Nuttall Herbarium); additional isotype (K).

77c *RANUNCULUS GMELINII* var. *HOOKERI* (D. Don) L. Benson
(Treatise:209)

Additional synonym.—*R. Gmelinii* var. *terrestris* (Ledeb.) L. Benson f. *Purshii* Fassett, Trans. Wis. Acad. Sci. 38:203. 1946.

Type collections.—(3) Var. *Hookeri*. Type (K) "*R. Purshii* β"; probable isotype (BM) ("Marshy ground near Cumberland House. 1827"). (12) Var. *prolificus*. Additional isotype (K).

The form (best known as var. *prolificus* [Fern.] Hara) discussed in the paragraph just below the middle of page 209 of the Treatise has been observed about springs on the north shore of Rogers Lake 15 miles west of Kalispell, Flathead County, Montana (*L. Benson* 14058 (POM)). It does not form a separate natural population but is sporadic in the general population. Possibly it has genes of *R. sceleratus* var. *multifidus* (*L. Benson* 14052 (POM)), which grows with *R. Gmelinii* var. *Hookeri* (*L. Benson* 14057 (POM)). There is nothing to indicate that these plants constitute a taxon worthy of a formal name. Occasional hybrid origin is likely in view of the disjunct distribution of the plants and occurrence at least westward with both possible parents (*R. sceleratus* var. *sceleratus* replacing var. *multifidus* eastward). Another collection of this form is the following: NORTH DAKOTA. BENSON CO.: Leeds, Lunell, June 24, 1900 (OB, MIN).

The writer now refers the form with parted petals (cf. Treatise:213) occurring at Leeds, North Dakota, and elsewhere to *R. Gmelinii* var. *Hookeri*, although this character occurs also in *R. flabellaris*. Evidently it does not mark a natural taxon but rather it is a gene occurring in a few members of a general population, such as var. *Hookeri* and the related species *R. flabellaris*. At McWinegar Slough just north of U. S. Highway 2 about 5 miles east of Kalispell, Flathead County, Montana, in 1949 the writer collected a series of specimens of *R. Gmelinii* var. *Hookeri*, *L. Benson*, 13953 (POM and duplicates). These aquatic and emersed forms shaded off into a markedly pubescent emersed form (*L. Benson* 13953a (POM)) not differing otherwise from var. *Hookeri* but reminiscent of var. *limosus*. The pubescent plants included some individuals with the irregularly parted petals characteristic of "var. *schizanthus*." The following Colorado specimens with notched petals are clearly *R.*

flabellaris: ROUTT CO.: 3 miles west of Milner, *Matsamura* 754 (CSC, POM).
MONTROSE CO.: Montrose, *Brewster* in 1892 (ILL).

78 RANUNCULUS FLABELLARIS Raf. (Treatise:211)

Additional synonym.—*R. flabellaris* f. *plenus* Boivin, Can. Field Nat. 65:4. 1951.

Type collections.—(1) *R. multifidus*. Isotype (BM), "Louisiana, Bradbury in 1811-12"; probable isotype (K), "No. 40. Dr. Taylor. Otto . . . [?] Bradbury." (2) *R. fluviatilis* Willd., as identified by Bigelow, the basis for (3) *R. flabellaris*. If the year does not represent the collection time of the specimen but rather the time it was received, the following may be the plant misidentified as *R. fluviatilis* by Bigelow: "Ranunculus paludosus mihi nectariis bilobis concavis," Bigelow, 1817 (G—DeCandolle Herbarium). A specimen in the Muhlenberg Herbarium (PA—American Philosophical Society) bears the following note "125 Ranunculus fluv. I will send a better specimen hereafter." Probably this was an isotype sent by Bigelow. Because this point is uncertain the plant can not be designated certainly as a lectotype, but it is designated as a neotype of *R. flabellaris* Raf., the basis for which was the plant misidentified as *R. fluviatilis* by Bigelow. (5) *R. lacustris*. The nature of the species is indicated by the following specimen: "Ponds in the Western Parts of the State of New York, Torrey"; "one of the varieties of this plant described in 1818 under the name of *R. delphinifolius*" (K). (10) *F. plenus*, "Typus: I. K. McMorine, Tennessee, Harriman, April 8, 1898 (DAO)."

"*R. Gmelinii* var. *schizanthus*" (Treatise:213). Cf. discussion above under 77c *R. Gmelinii* var. *Hookeri*.

79a RANUNCULUS CYMBALARIA var. CYMBALARIA, replacing var. *typicus* (Treatise:215)

This variety does not occur in South America.

Type collections.—(1) *R. Cymbalaria*. "In saline marshes near the salt-works of Onondago, New York. . . . June, July." Type (PA—American Philosophical Society Herbarium of Benjamin Smith Barton in whose behalf Pursh collected the specimens). Additional topotype (K) ("Salt Springs, Onondago, New York, Asa Gray, 1840"). (2) *R. nanus*. Type represented by a sketch, (G—DeCandolle Herbarium) ("Mr. Fisher. 1819"). (5) *F. hebecaulis*. Additional isotypes (MIN 241124, 241186).

79b RANUNCULUS CYMBALARIA var. ALPINUS (not *alpina*, cf. statement under No. 40b) Hook. (Treatise:216)

79c RANUNCULUS CYMBALARIA var. SAXIMONTANUS Fern. (Treatise:216)

This is at least the prevailing type in South America.

Additional significant specimen.—MINNESOTA. CHIPPEWA CO.: Montevideo, *Moyle* in 1893 (MIN).

Type collections.—(1) Var. *major*, also the basis for var. *saximontanus*. Type (P—H. B. K. Herbarium), "Carpio," *Bonpland* 4053.

80 RANUNCULUS RANUNCULINUS (Nutt.) Rybd. (Treatise:218)

Type collections.—(1) *R. ranunculinus*. Type (BM), additional isotype (K).

81 RANUNCULUS COOLEYAE Vasey & Rose (Treatise:220)

Type collections.—Type (US 15184), photograph (S), additional isotype (K).

83 RANUNCULUS TESTICULATUS Crantz (Treatise:222)

Additional specimens examined.—WASHINGTON, ADAMS CO.: Macall, *Jeffrey* in 1946 (UC). COLORADO, MESA CO.: Between Fruita and Colorado National Monument Headquarters, *Weber* 3771 (POM).

RANUNCULUS FALCATUS L. (Treatise:222)

Type collection.—“*Habitat inter segetes Europae australis.*” Sheet number 71 in the Linnaean Herbarium, Linnaean Society, London, is designated as a lectotype.

84 RANUNCULUS KAMCHATICUS DC. (Treatise:223)

Additional specimens examined.—ALASKA. Aleutian Islands. Atka, *Eyerdam* 1013 (S), *Hultén* 6552 (S); Carlisle Island, *Hultén* 6576 (S); Rat Island, *Hultén* 5990 (S). Shumigan Islands. Popof Island, *Kincaid* in 1899 (S).

Type collections.—(1) *R. kamchaticus*. Type (G—DeCandolle Herbarium) (ex *Pallas*) (a small plant with young fruit).

85 RANUNCULUS GLACIALIS var. GLACIALIS, replacing var. *genuinus* (Treatise:225)

The habitat of this species was observed in Swedish Lapland in 1950 (northeast of the source of the Raikenjira (Hole Brook), base of Låktatjåkko above Kopparåsen, south side of Lake Torneträsk, (plants observed but not collected for lack of flowers or fruits); east side of Snoritjåkko, north side of Lake Torneträsk, *L. Benson* 14490 (POM). The species grows in the moist soil of rocky places recently uncovered by melting of snow.

Type collection.—Sheet number 37 in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype.

85b RANUNCULUS GLACIALIS var. CHAMISSONIS (Schlecht.) *L. Benson* (Treatise:226)

The emendation of spelling by Ledebour now is adopted.

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 254.

Additional specimens examined.—(Duplicates of specimens cited previously). ALASKA. Little Diomedé Island, *A. E. and R. T. Persild* 1693 (S); Gambell, St. Lawrence Island, *J. P. Anderson* 3701 (S); Wales, *J. P. Anderson* 4946 (S) (collection not seen previously). Cape Prince of Wales, *J. W. Hutchinson* 664 (K), 665 (K).

Type collections.—Isotype (K), “*Sin. St. Laurentii. A. v. Ch[amisso].*” Topotype, St. Lawrence Bay, Arctic Siberia, Bering Sea, 65°30' N 17° W, *Kjellman* in 1879 (S).

87 RANUNCULUS JUNIPERINUS M. E. Jones (Treatise:226)

This species was observed in the field on May 7, 1949 (one quarter mile east of the Zion National Park Boundary on a north slope just south of the road to Kanab, 6,250 feet elevation, *L. Benson* 13695 (POM)). It grew in still-moist sand under scattered yellow pines and scrub oaks (*Quercus Gambelii*). The species is an early-flowering one, and this collection was made at probably the extreme of altitude and the end of the flowering season. Most of the plants were in fruit.

Type collections.—(2) *R. juniperinus*. Additional isotype (BM).

87 RANUNCULUS ANDERSONII A. Gray (Treatise:227)

Type collections.—(1) *R. Andersonii*. Additional isotype (K). (2) *Beckwithia Austinae*. It is to be noted that this is not *Ranunculus Austinae* Greene, a synonym for 61 *R. glaberrimus* Hook.

88 RANUNCULUS HEDERACEUS L. (Treatise:230)

Type collections.—No specimen was found in 1950 in the Clifford Herbarium (BM). Sheet number 74 in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype.

89 RANUNCULUS LOBBII (Hiern) A. Gray (Treatise:231)

Type collections.—Type (K).

90a RANUNCULUS AQUATILIS var. AQUATILIS, replacing var. *typicus* (Treatise:232)

Spelling variant.—*R. aquaticus* Poir. in Lam. Encyc. Meth. 6:130. 1804.

Field observation in Europe during the summer of 1950 does not indicate marked differentiation of the European population of *R. aquatilis* var. *aquatilis* from var. *hispidulus*, of the Pacific Coast of North America. In turn var. *hispidulus* is not strongly distinguished from *R. aquatilis* var. *capillaceus* of both continents. Specific segregation of var. *capillaceus* (under the typonym *R. trichophyllus*) can be justified only under an exceedingly liberal policy, which would call for consideration of each of the seven North American varieties of *R. aquatilis* to be designated as a distinct species. Construction of a workable key for "species" on this level is impossible, and such a treatment of the group is impractical.

Those who are impressed by differences in flower size of *R. aquatilis* var. *aquatilis* and "*R. trichophyllus*" should note not only the inconsistency of this feature in var. *aquatilis* and the occurrence of a common and widespread West American variety (var. *hispidulus*) with floating leaves and small petals (4-6 mm. long) but also occurrence of a robust West American variety (var. *Harrisii*) with no floating leaves and with petals 8-10 mm. long (cf. *L. Benson* 14748 (POM and duplicates)). The petals of var. *aquatilis* are most commonly from 9-14 mm. long, but the writer found variability in the same pond, plants with the usual petal length and others with petals ranging from 5-10 mm. long (Bookham Common, Surrey, England, *L. Benson* 14345 (POM)). If more than local forms are considered, there is no ground for segregation of "*R. trichophyllus*" from *R. aquatilis*. As shown below, taking up the epithet *trichophyllus* for the whole complex on the basis of alleged questionable nomenclatorial status of *aquatilis* is not justified, either.

Type collections.—Argument concerning use of the name *R. aquatilis* has centered about typification of the species. It has been argued that the epithet *aquatilis* has been applied by some authors to almost any aquatic buttercup. This may or may not be true, but under the type method it makes no difference, provided the type can be established. The description given by Linnaeus does not allow much latitude, for few forms qualify as follows: "*RANUNCULUS foliis submersis capillaceis, emersis peltatis.*" He refers, further, to other works describing a European plant with both submerged, dissected ("capillary") leaves and floating non-dissected ("peltate") leaves. Sheet number 75 in the Linnaean Herbarium, Linnaean Society of London, is essentially the plant long referred to as the "typical *R. aquatilis*." The specimen is a good one.* The obstacles to its acceptance as the type are lack of evidence that it was in the Herbarium of Linnaeus in 1753 and the relatively deep primary division of the leaves, making them not strictly peltate in even the sense employed evidently by Linnaeus (actually *reniform*, because none of the Batrachian or other *Ranunculi* have truly *peltate* leaves in the present usage of the term,

* The floating leaves are divided deeply. This agrees with the form described as *R. aquatilis* var. *heterophyllus* (Hoffm.) DC. Syst. 234. 1818 (*R. heterophyllus* Hoffm.). DeCandolle described these plants as follows: "*foliis emersis tripartitis non peltatis.*" Other forms have less divided floating leaves. These are *R. aquatilis* var. *peltatus* (Schrank) DC. (*R. peltatus* Schrank). DeCandolle described these plants as follows: "*foliis emersis orbiculatis trilobis peltatis.*" This distinction does not seem significant in view of the great variability of leaf dissection in the emersed leaves of vars. *aquatilis* and *hispidulus*.

i.e. with the petiole attached to the under surface, the basal sinus being closed). Savage, Catalog of the Linnaean Herbarium, has used the number 1 to indicate specimens present in 1753, 2 to indicate those present in 1755, and 3 to indicate those present in 1767. Sheet number 75 is known to have been present in 1767, but it may not have been in the Linnaean Herbarium earlier. The other two sheets (not mentioned above) in the Linnaean Herbarium (London) may be excluded, as not being the source of the description published by Linnaeus, for number 76 has no floating (non-dissected) leaves, and number 77 has only stems and young fruits.

Investigation of the large collection of Linnaean specimens in the Linnaean Herbarium at the Naturhistoriska Riksmuseet at Stockholm (collections of Linnaeus's students and correspondents including many specimens given to them by Linnaeus from his own herbarium) did not yield positive results. One sheet is labelled, possibly by Solander (who, with Linnaeus's son, helped Linnaeus with the clerical work of the herbarium), "*Ranunculus foliis submersis capillaceus, emersis peltatis* Lin. Spec. Plant. 556. 37 [the number of the species in *Species Plantarum*]." It bears also "*Herb. Caströmii Fl. Sv. 472β*." Possibly Linnaeus gave this sheet to Caström. Since the writing is not that of Linnaeus, it cannot be shown positively that this specimen can qualify as a lectotype. Another sheet at Stockholm bears the legend, "37 *aquatilis*," probably but not certainly in the writing of the younger Linnaeus. On a third sheet all the writing seems to be by later authors than Linnaeus.

Another specimen likely known to Linnaeus is in the Burser Herbarium at the University of Uppsala. This is Burser Volume IX, No. 120, photograph (POM) (through the kindness of Prof. J. A. Nannfeldt and Dr. Carl G. Alm). In this specimen the floating leaves are palmately 3-lobed only for about one-third the distance to the bases, corresponding with the form called *R. aquatilis* var. *peltatus* (Schrank) DC. (*R. peltatus* Schrank) and corresponding with the key word "peltatis" in Linnaeus's description of *R. aquatilis*. The specimen is a good one.

The Seventh International Botanical Congress at Stockholm set up a method for providing a positive solution to such problems as this one by the requirement of selection of a lectotype or a neotype (Article 18, International Code of Botanical Nomenclature, cf. discussion in the Introduction to this paper, p. 330). However, pending completion of further study now in progress on this problem, selection of a lectotype or neotype is postponed. Fortunately, in this case, despite confusion in some post-Linnaean literature, there is little doubt of the intention of Linnaeus or of which taxon he was describing.

The writer is indebted to Mr. J. E. Dandy of the British Museum of Natural History for consultation and advice on this problem.

90b *RANUNCULUS AQUATILIS* var. *HISPIDULUS* E. Drew (Treatise:232)

Additional significant specimen.—MONTANA. MISSOULA CO.: Nine (?) Mile Mountain, Barkley 2586 (MO).

Type collections.—(1) Var. *hispidulus*, "In ponds at Jarnigan's, Mad River, [Humboldt County, California,] July 10." Chesnut & Drew in 1888. According to the publication cited above, the type specimen was collected July 10, 1888, but the only herbarium sheet in the collections of Chesnut and Drew is dated July 21, 1888, (UC 13972). Because the specimens at Berkeley are not a duplicate set but the original, the type should be expected to be at the University of California. According to the paper by Chesnut and Drew other collections (page 150) were made on the "western side of South Fork Mountain, July 21." The writer is indebted to Dr. Helen K. Sharsmith and Mr. G. Thomas Robbins of the University of California for further information. According to a letter from Dr. Sharsmith (March 23, 1953), Jarnigan's was "... in central Humboldt County six miles southeast of Kneeland on the west side of Mad River. ... In pre-automobile days it would not have been possible to collect both at Jarnigan's and South Fork Mountain in one day." Loose notebook pages in the Jepson Herbarium of the University of California bear Chesnut and Drew's field notes. For July 10 there is no entry; for July 11, the following: "Near Jarnigan's (53-101)"; for July 21: "South Fork Mountain, west slope (125-133)." The only *Ranunculus* collected at any time is number 52, listed as follows:

"52 *Ranunculus hederaceus* var. *Lobbii*
July 11—near Jarnigan's
53. ..."

Evidently the identification was a temporary one made in the field and the plant was that subsequently named as the new variety of (the related) *R. aquatilis*.

An arrow points from the line beginning with "52" to "July 11" on the line below. The herbarium sheet at the University of California was labelled first as July 11 but a 2 has been written over the first 1, making the day "21." Evidently this is the original collection of var. *hispidulus*, so named later than the entry in the field book. Probably either it was collected on the 10th. of July (perhaps the only specimen of the day) and listed with the collections of the 11th. or it was collected actually on the 11th. Certainly it was not collected on July 21. Almost but not quite certainly UC 13972 is the holotype, but because this can be questioned it is designated as a lectotype. Lectotype (UC 13972). The only known duplicate of the specimen discussed above is at the University of Notre Dame (HGR 3032), "... Jarnigan's July 1888." Almost but not quite certainly this specimen is a duplicate of the lectotype (or holotype) and thus at least essentially an isotype. The writer is indebted to Dr. Albert Delisle of the University of Notre Dame for rechecking the data on this specimen (examined by the writer in 1935).

90d *RANUNCULUS AQUATILIS* var. *HARRISII* L. Benson
(Treatise:236)

Additional specimens examined.—CALIFORNIA. SHASTA CO.: Hat Creek, 13.5 miles north of Manzanita Lake, *L. Benson* 13748 (POM and duplicates). Petals in this collection range up to 10 mm. long. The plants grew in swift water of a mountain stream. Cattle were observed standing in the stream eating them in preference to other food. BUTTE CO.: "Wet meadows at Butte Meadows in the yellow pine belt," *Heller* 14674 (G); *Jonesville, E. B. Copeland* 360 in 1929 (G).

90e *RANUNCULUS AQUATILIS* var. *CAPILLACEUS* (Thuill.) DC.
(Treatise:237)

Additional synonym.—*R. pantothrix* Brot. var. *capillaceus* DC. Syst. 1:235. 1818.

Delete synonym.—*R. amphibius* James.

This is the representative of the subgenus occurring in South America.

Desfontaines, Fl. Atl. 1:442. 1798, listed two varieties under "*R. aquaticus*." A was *R. aquaticus capillaceus*; B was a polynomial. Since Desfontaines did not apply single varietal epithets with consistency, probably *R. aquaticus capillaceus* should be dismissed from consideration as use of a varietal epithet in the modern sense. This information was supplied through the kindness of Dr. H. W. Rickett of the New York Botanical Garden.

A form with elongate petioles, capillary leaf segments, and slender fruiting pedicels 6.5-10 cm. long occurs in the Aleutian Islands (Adak on the inland side of Lake Andrew, elevation 20 feet, *L. Benson* 14989 (POM, US)). Similar plants are occasional at least from Alaska to Minnesota, but varietal segregation appears to be unwarranted.

Type collections.—Delete (3) *R. amphibius* and renumber (4) as (3), etc. (3) Var. *brachypus*. Type (K). (4) *Batrachium Bakeri*. Additional isotypes (G, K, P). (6) *B. pedunculare*. Additional isotype (G).

90g *RANUNCULUS AQUATILIS* var. *ERADICATUS* Laestad.
(Treatise:239)

See the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 254.

91a *RANUNCULUS CIRCINATUS* var. *CIRCINATUS*

Ranunculus circinatus Sibth. Fl. Oxon. 175. 1794.

Type collection.—"Christ-Church Meadow—South Leigh," England. A search was made at Oxford University in the summer of 1950 for the type specimen. However, none

was found in the Sibthorp Herbarium. Unfortunately, it was Sibthorp's practice to describe readily available plants from living material and not necessarily to save a specimen.

91b *RANUNCULUS CIRCINATUS* Sibth. var. *SUBRIGIDUS* (W. Drew)
L. Benson (Treatise:240)

Additional synonym.—*R. amphibius* James, Long Exped. Rocky Mts. 1:498, 1823. (Note that in specific rank this combination long antedates *R. subrigidus* W. Drew.)

Type collections.—(2) *R. amphibius*, "Platte River west of the mouth of Portera's Creek." Type (NY). This collection has come to light again, and its identity is now definite.

R. Codyanus Boivin, Can. Field Nat. 65:3. *unnumbered pl.* 1951, is either a northern depauperate form of *R. circinatus* var. *subrigidus* or a variety of *R. circinatus* in its own right. The type material may be described as follows: Leaf segments with numerous appressed stiff hairs; leaf blade only about 6 mm. long, divided only about twice, the segments few; stamens short; achenes about 12-16. However, recent collections have glabrous leaves and only a few stem hairs, cf. collections by Bruggemann below under "specimens examined."

Canada. Pool on Southampton Island, at Coral Harbor, South Bay, Kewatin, and at the R. C. Mission, Repulse Bay, Melville Peninsula.

Specimens examined.—KEEWATIN: Southampton Island, Coral Harbor, South Bay, 64°08'N, 83°17'W, *Cody* 1518 (DAO), 1712 (DAO type), POM (isotype); Repulse Bay, Melville Peninsula, 66°31'N, 86°15'W, *P. F. Bruggemann* 79, Aug. 3, 1950 (DAO); ("among mosses in shallow pond. Growing submerged among mosses and also forming small mats on silt bottom in shallow water about 5 cm. deep"), near Cape Belknap, northeastern Ellesmere Island, 82°32'N, 62°18'W, *P. F. Bruggemann* 285, Aug. 24, 1951 (DAO, POM); (shallow pond near [1 mile southwest of] Cape Belknap and airstrip beginning to dry up. A few stands in open shallow water but mostly along margins of large mats of mosses"), 82°31'N, 62°17'W, *P. F. Bruggemann* 224, July 28, 1951 (DAO, POM). (In the Bruggemann collections the labels on the specimens at Pomona College are somewhat abridged or the wording is slightly altered.) More collections are necessary in order to evaluate the status of these far-northern plants.

Type collection.—"W. J. Cody 1712, Southampton Island, Coral Harbor, South Bay, near beach, in muck around drying up pool and in water, 3 inches high, rooted in muck, very common in one pool only, Aug. 1, 1948 (DAO. *typus* et *isotypus*, *isotypi* 8 *distribuenti*) . . ." Type (DAO); isotypes, (MIN 414118, POM 279244). The other collection by Cody from the same pool has been examined also: *Cody* 1518 (DAO).

92 *RANUNCULUS LONGIROSTRIS* Godron (Treatise:243)

Type collections.—(1) *R. longirostris*. Type (P); isotype (K) ("Eaux courantes, St. Louis, Missouri, Juin 1838, 52" N. Riehl). (2) *R. usneoides*. The type was not found in the Herbarium Greeneanum in 1935, and a recheck through the kindness of Drs. John D. Mizelle and Albert L. Delisle does not reveal it. Consequently the following collection which Greene probably studied during his stay at the National Herbarium is designated as a lectotype, pending finding a specimen in the Herbarium Greeneanum: (US 615523), photographs (NY, K).

Additional significant specimen.—MONTANA. LAKE CO.: Stream above Kicking Horse Reservoir, west base of Mission Mountains, *L. Benson* 13946 (POM). It is to be noted that this and other collections show the abrupt curve at base of the fruiting pedicel characteristic also of *R. circinatus* var. *subrigidus* but not of *R. aquatilis*.

93 *RANUNCULUS PUEBLENSIS* W. Drew (Treatise:245)

Additional specimens examined.—MEXICO. HIDALGO: "Norte de pueblo viejo a real Del Monte" *Berlandier* (G). "Entre Tampico et Real del Monte, 15/5/1827," *Berlandier* 427 (G) possibly from Vera Cruz, another sheet, *Berlandier* 427 (G) without data.

94 RANUNCULUS PALLASII Schlecht. (Treatise:246)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 255.

Type collections.—Probable isotype, "Ins. Georgii" (K). Assuming that the type was destroyed in the World War II bombing of Germany, this specimen is designated as a lectotype.

95 RANUNCULUS LAPPONICUS L. (Treatise:247)

See also the paper entitled *The Ranunculi of the Alaskan Arctic Coastal Plain and the Brooks Range*, p. 255.

Additional significant specimens.—MINNESOTA. ST. LOUIS CO.: 1 mile from Jasper Peak, Soudan, *Lakela* 11088 (MIN, POM); northeast of Jasper Peak, Soudan, *Lakela* 8448 (MIN, POM), ITASKA CO.: *Huff* in 1929 (MIN); halfway between Effie and Togo, *Rosendahl & Butters* 6851 (MIN).

Type collections.—Sheet number 43 in the Linnaean Herbarium, Linnaean Society of London is designated as a lectotype.

96 RANUNCULUS FICARIA L. (Treatise:248)

Type collection.—Sheet number 12 in the Linnaean Herbarium, Linnaean Society of London, is designated as a lectotype.

Studies in and near Michigan's Tension Zone: I. A Northward Extension for the Range of *Ulmus Thomasi* Sarg.*

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The northern limits of distribution for *Ulmus Thomasi* Sarg., in Michigan, have long been considered to correspond rather closely with the northern limits of the zone of tension in the state's lower peninsula. These limits, as mapped by Harlow and Harrar (1950:386), Hough (1947:184) and the Dominion Forest Service (1942:186), are shown in Fig. 1.

Ulmus Thomasi Sarg. is not mentioned as a part of the forest community for the upper portion of Michigan's lower peninsula in the literature of The Mixed Conifer-Northern Hardwood Forests of The Northeastern United States (Frothingham 1915; Nichols 1935; Braun 1950). Of the extensive literature on the forest composition in the state's lower peninsula (Beal 1888, 1889, 1903; Beal and Wheeler 1892; Whitford 1901; Sherrard 1902; Livingston 1903, 1905; Clayberg 1920; Quick 1923; Gleason 1924; Woollett and Sigler 1928; Dice 1931; Cain 1935; Potzger 1946) only two, Livingston (1905) and Quick (1923), mention the rock elm (*Ulmus Thomasi* Sarg.) as a constituent of the forest community.

Livingston (1905) listed *Ulmus Thomasi* Sarg. (under the synonymous name *Ulmus racemosa* Thomas.) among the trees characteristic of the hardwood forest type in Roscommon and Crawford counties, Michigan (fig. 1). These stations are north of the distributional limits for the species, as shown in fig. 1. Quick (1923) wrote that in the southern boundary of his Region IV (largely the western part of the lower peninsula of the state, north of the Grand River), some species of more southern distribution occurred: "... *Ulmus racemosa* Thomas. (*Ulmus Thomasi* Sarg.) at Hart." This station, located near the north central part of Oceana County, is within the limits of reported distribution for the species (fig. 1).

An analysis of the quantitative data from 546 5 x 20 meter quadrats, located in 98 stands of upland second growth hardwoods in Missaukee County, Michigan (fig. 1) indicates that *Ulmus Thomasi* Sarg. is a very important secondary dominant for this forest community. These data, compiled during a phytosociological study of the upland second growth hardwoods of this county, are presented in tables 1 and 2. An inspection of the tables shows clearly that the species has a prominent place in this forest community, ranking fourth on the Density-Frequency-Dominance Index (Curtis 1947).

Missaukee County is somewhat north of the reported northern limits of distribution for *Ulmus Thomasi* Sarg. (fig. 1). The nearness of the county to the northern limits of the range for the species should result in critical growth conditions for the tree (Cain 1942:19). However, these data (tables

* Contribution No. 54-6 from the Department of Botany and Plant Pathology, Michigan State College, East Lansing.

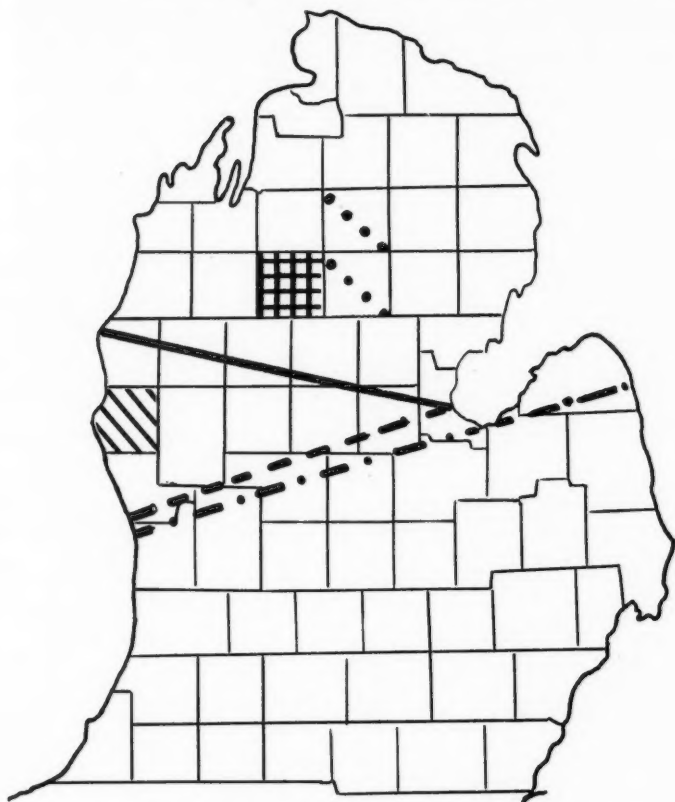


Fig. 1.—Northern limits of distribution for *Ulmus Thomasi* Sarg.

LEGEND: Solid line = Hough; Broken line = Harlow and Harrar; Dot-dash line = Dominion Forest Service; Diagonal lined area = Oceana Co.; Cross hatched area = Missaukee Co.; Dotted line = Crawford and Roscommon Co.

1 and 2) indicate that such is not the case. Not only is the rock elm a prominent member of the forest community in numbers, but it is also found with considerable regularity throughout the 98 stands within the county. It would appear that this is evidence suggesting a northward extension of the range of *Ulmus Thomasi* Sarg. As such, it is here considered as previously overlooked as a member of the forest community in this area and it is suggested that notice of this northward extension be taken in any future revisions of the distribution maps for the species.

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TABLE 1.—Summary data for the tree species based on 546 5 x 20 meter quadrats in the 98 stands of upland second growth hardwoods in Missaukee County, Michigan

	F	TOTALS D	BA	DFD #
	%	%	%	
<i>Acer saccharum</i>	94.1	61.0	35.8	1
<i>Fagus grandifolia</i>	50.7	8.0	12.7	2
<i>Ulmus americana</i>	32.8	3.8	12.9	3
<i>Ulmus Thomasi</i>	22.5	4.0	10.9	4
<i>Tilia americana</i>	25.8	2.8	6.2	5
<i>Ostrya virginiana</i>	26.0	2.8	1.7	6
<i>Fraxinus americana</i>	19.0	2.0	3.0	7
<i>Prunus pensylvanica</i>	16.5	3.4	.3	8
<i>Acer rubrum</i>	13.2	3.9	2.2	9
<i>Quercus rubra</i> *	10.8	1.8	3.2	10
<i>Populus grandidentata</i>	10.4	2.5	2.2	11
<i>Tsuga canadensis</i>	11.7	.8	2.0	12
<i>Prunus serotina</i>	10.6	.7	2.5	13
<i>Ulmus rubra</i>	10.6	1.0	1.0	14
<i>Betula lutea</i>	5.7	.3	.5	15
<i>Quercus alba</i>	2.8	.5	.7	16
<i>Betula papyrifera</i>	2.9	.2	.4	17
<i>Amelanchier</i> sp.	1.7	.4	.0	18
<i>Populus tremuloides</i>	1.5	.2	.1	19
<i>Pinus strobus</i>	1.3	.1	.3	20
<i>Thuja occidentalis</i>	1.3	.1	.2	21
<i>Pinus resinosa</i>	1.0	.1	.1	22
<i>Fraxinus nigra</i>	.4	.1	.0	23

* *Quercus rubra* var. *borealis*.

F—Frequency, D—Density, BA—Basal Area, #—Density-Frequency-Dominance Index (Curtis '47).

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TABLE 2.—Summary data for the tree species by size classes based on 546 5 x 20 meter quadrats in the 98 stands of upland second growth hardwoods of Missaukee County, Michigan.

	SIZE CLASS TOTALS									
	2		3		4		5		6	
	%	%	%	%	%	%	%	%	%	%
	F	D	F	D	F	D	F	D	F	D
<i>Acer saccharum</i>	76.9	66.6	86.8	65.7	73.6	45.8	30.0	23.9	6.2	29.2
<i>Fagus grandifolia</i>	27.1	7.9	26.0	7.8	24.4	6.8	17.4	16.1	4.8	19.7
<i>Ulmus americana</i>	7.7	2.2	11.9	2.9	21.1	6.3	13.4	15.7	3.5	14.6
<i>Ulmus Thomasi</i>	6.8	2.0	11.4	3.1	17.6	7.7	10.4	14.8	1.7	12.4
<i>Tilia americana</i>	7.7	1.5	9.5	2.0	17.7	6.3	6.8	6.5	1.8	9.5
<i>Ostrya virginiana</i>	7.9	1.9	17.4	4.3	14.8	3.6	.9	.7		
<i>Fraxinus americana</i>	5.3	1.3	8.4	1.8	11.9	3.9	3.6	3.5		
<i>Prunus pensylvanica</i>	13.9	6.1	5.7	1.3	.4	.1				
<i>Acer rubrum</i>	8.2	3.5	9.3	4.7	8.2	4.3	1.3	1.1		
<i>Quercus rubra</i> *	3.9	.8	5.0	1.7	8.8	3.9	2.4	3.2	.4	2.2
<i>Populus grandidentata</i>	6.0	3.1	3.1	.9	7.3	3.3	2.9	2.4	.2	1.5
<i>Tsuga canadensis</i>	3.5	.8	2.4	.5	4.2	.9	2.0	1.7	1.3	4.4
<i>Prunus serotina</i>	1.7	.2	2.6	.5	6.4	1.6	4.5	4.7	2.2	3.7
<i>Ulmus rubra</i>	2.0	.7	4.2	.7	6.4	1.9	3.1	3.1	.4	1.5
<i>Betula lutea</i>	.5	.1	2.2	.4	4.2	.9	.5	.5		
<i>Quercus alba</i>	1.5	.5	1.7	.5	2.0	.9	.5	.5		
<i>Betula papyrifera</i>			2.0	.4	2.4	1.0				
<i>Amelanchier</i> sp.	1.3	.5	.9	.4	.2					
<i>Populus tremuloides</i>	.5	.2	.7	.3	.9	.2				
<i>Pinus Strobus</i>	.7	.1	.2	.1	.2	.1	.4	.6	.1	.7
<i>Thuja occidentalis</i>	.2	.1	.7	.1	.7	.1				
<i>Pinus resinosa</i>	.4	.1			.1				.2	.7
<i>Fraxinus nigra</i>			.1	.1	.4	.1				

* *Quercus rubra* var. *borealis*.

F—Frequency, D—Density.

Observations on Petiolar Branching and Foliage of an American *Botryopteris*

Theodore Delevoryas and Jeanne Morgan
University of Illinois, Urbana

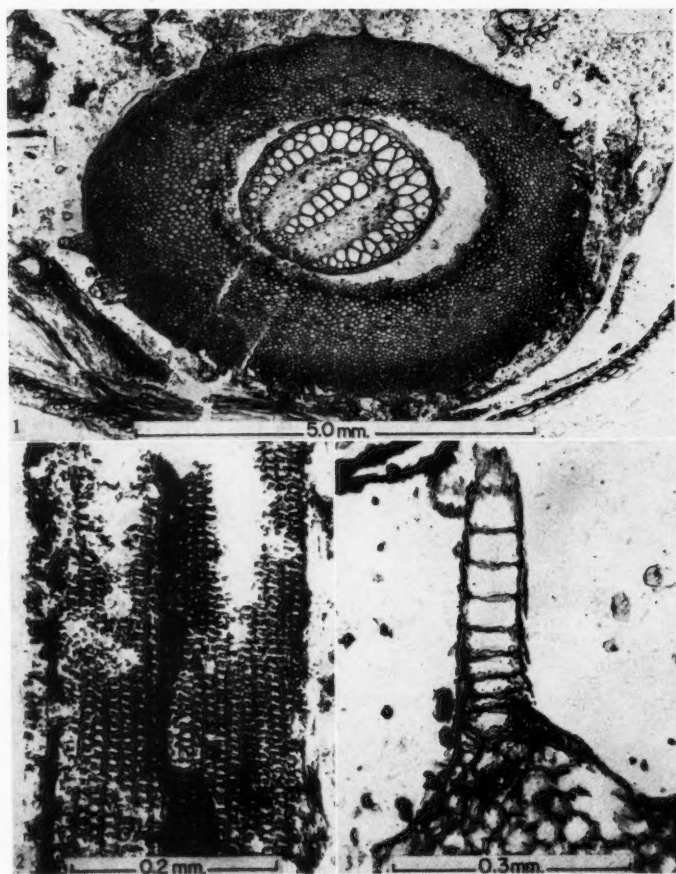
A genus which has received a considerable amount of attention both in Europe and America but which still remains a perplexing one is that of *Botryopteris*, founded by Renault in 1875. The most recent comprehensive work on the genus was completed in 1937 by Corsin who prepared a comparative study of some of the known species including a discussion of synonymy among members of the group. One of the most thoroughly described forms is *B. forensis* Renault (1875), a species the petiolar branching of which was first postulated by Bertrand (1913). This suggestion of Bertrand was followed by Corsin with accompanying cross-sectional diagrams.

Graham (1935) differentiated a new species, *B. americana*, on the basis of a supposedly different type of petiolar ramification. In 1941 Darrah described additional specimens of *B. americana*, and diagrammatically reconstructed the method of branching of a petiole trace.

Coal-ball material from the Berryville collecting locality of the McLeansboro group in southeastern Illinois has shown the exact method of branching of the petiole trace which has been followed with close serial sections. The specimens were complete enough to discredit the hypothetical method of branching postulated by Bertrand and to substantiate the type suggested by Graham on the basis of a single cross-section.

Although the suggestion of the possession of leaves by certain members of the genus has been reported (Renault, 1896; Kraentzel, 1934; Darrah, 1941), the general consensus of opinion was that no laminations of any kind are borne on the lateral appendages (Andrews, 1951). The structure of the plants is thought to represent a primitive condition transitional between a psilophytic branching system and a true fern frond. With the present discovery of fern-like, pinnule-bearing pinnae assignable to *Botryopteris*, it is suggested that although the genus is a relatively primitive one, it may occupy a somewhat more advanced phyletic position than was previously assigned to it.

Description of petiolar axes.—As in *B. forensis*, the petioles of our specimens possess an ω -shaped strand of metaxylem, with protoxylem situated at the tips and to some extent around the outer flanks of the two lateral arms (fig. 1). Protoxylem elements are annular, spiral, and scalariform, while metaxylem tracheids possess multiseriate circular bordered pits (fig. 2). The innermost cortex surrounding the traces is lost in all the specimens, its extent being indicated only by a completely unpreserved zone about the strand. Immediately surrounding this cavity in larger axes is a thin band of sclerenchyma. Outside the sclerenchyma are two zones of the cortex, the inner zone of which is composed of relatively large, thin-walled cells in contrast to the denser outer zone. From the epidermis arise long, unbranched, multicellular hairs (figs. 1, 3). The largest of the petioles average 6 mm in diameter, with progressively smaller dimensions for axes of secondary, tertiary, and even higher degrees of pinnation.



Figs. 1-3.—1. Transverse section of one of the larger *Botryopteris* petioles. 2. Multi-seriate circular bordered pitting on metaxylem elements in the petiole. 3. A single unbranched multicellular hair arising from the epidermis.

Method of branching (fig. 4).—The first indication of the formation of a trace from the vascular bundle of the petiole is the bending outward of a portion of one of the lateral arms (fig. 5). This lateral member becomes more concave as the bending outward and backward proceeds; at the same time the original arm is reconstituting itself (fig. 6). After the departure of the concave strand (fig. 7), the forming of a median arm on the inner face of the lateral trace results in the duplication of the ω configuration like that of the original trace. In two of the specimens this same type of petiolar branch-

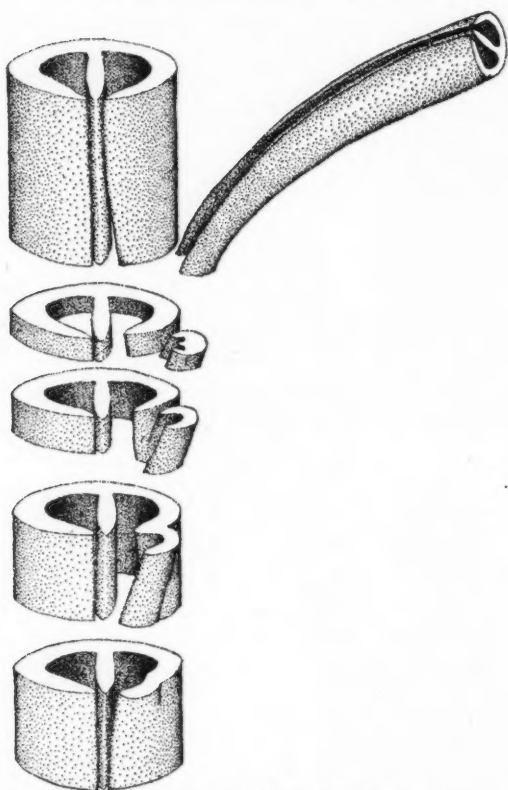
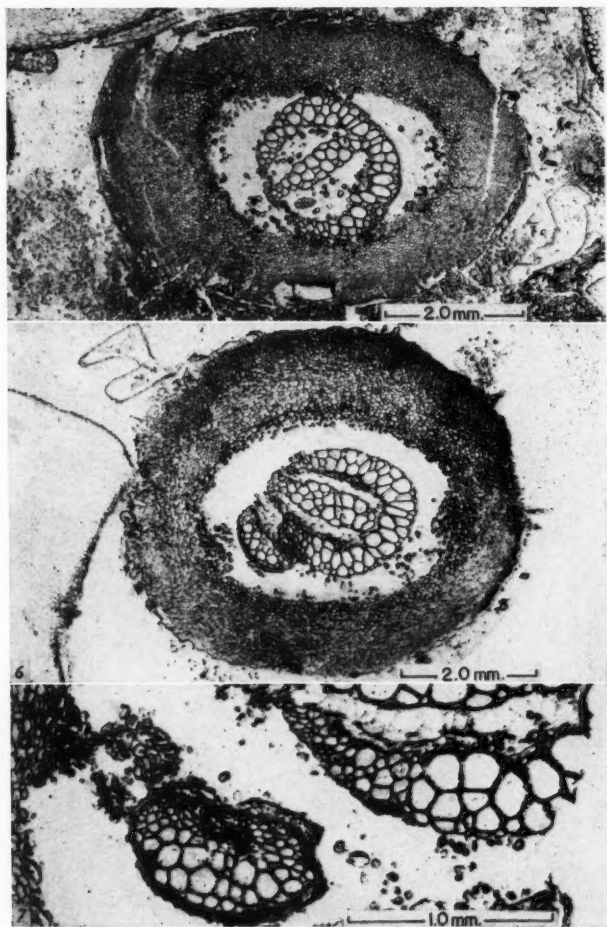


Fig. 4.—Diagrammatic reconstruction of the formation and departure of a lateral trace from the petiole strand. Traces are shown sectioned at various intervals to show their cross-sectional appearance at these levels.

ing occurs from the secondary trace soon after the departure of the latter from the primary strand (figs. 8-10). This happens through such a short distance that the resulting three traces are, for a time, confined within the same cortex. As a result of these divisions the primary and tertiary axes proceed nearly parallel to each other and perpendicular to the secondary member (fig. 10).^{*} In the several specimens both the right and the left arms of the xylem strand were involved in trace formation so that it is likely that secondary traces were given off in a pinnate manner.

To the right of the tertiary axis illustrated in fig. 10 can be seen a bulbous projection seemingly composed only of parenchyma cells. The surface is densely covered with many of the typical multicellular botryopterid hairs and

^{*} The axes are termed primary, secondary, tertiary, etc., on the basis of their order of attachment within the coal ball.



Figs. 5-7.—5. Transverse section of a petiole showing a portion of the lateral arm in the lower center of the picture beginning to bend outward and backward in an early stage of lateral trace formation. 6. A later stage in trace formation at a point below the separation of the lateral member. 7. Trace after departure from the lateral arm of the petiole strand and before it has assumed the ω configuration.

although this parenchymatous mass is very likely attached to the petiolar system, this assumption cannot be ascertained since that structure is absent on the face of the coal ball opposite the saw cut. This condition has been observed in only one specimen and does not appear to be a constant feature.

In one instance, a small terete bundle was observed arising from one of

the petiolar strands and proceeding perpendicular to it. This bundle is thought to represent the trace of an adventitious root. Mamay and Andrews (1950) report two questionable cases of adventitious roots originating from an ω -shaped petiolar strand of *B. tristecta*.

Pinnae and pinnules.—Trace formation was observed in axes of much smaller diameter than the larger petioles, and in each case the strands bear the ω configuration (fig. 11). The axes resulting from these divisions are the ultimate pinnule-bearing members and are characterized by two prominent ribs on their adaxial surface (figs. 12, 13). The vascular trace passing through these axes is ω -shaped with the free arms in an adaxial position (fig. 15). Axes labeled p_4 , p_5 , and the pinnules (figs. 12, 13) are arranged in the same plane.

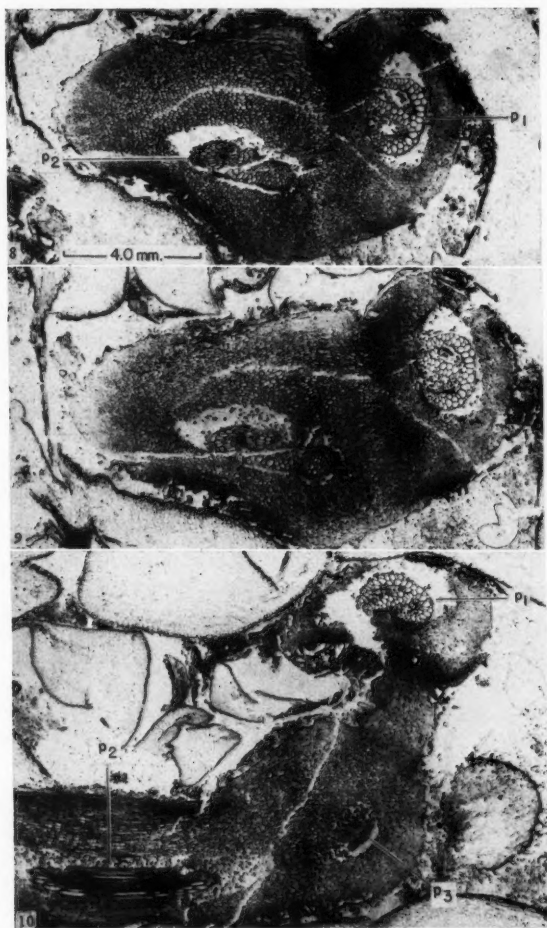
Pinnules are attached broadly by their contracted bases along the adaxial surface of the ultimate pinnae (figs. 13, 14). These pinnules average 4 mm in width and reach 1.5 cm or more in length. In cross-section the expanded blade of the pinnule is seen to arch on either side of the prominent midrib (fig. 17). The recurved margins are regularly once-lobed along their entire length (figs. 13, 18). From the single terete midvein arise lateral veins; one lateral vein traverses the middle of each lobe. These strands in turn give rise to smaller traces within the lobe (fig. 18) which dichotomize toward their distal extremities. Due to the convex nature of the pinnules it is difficult to illustrate all of the characters of these lateral members in a single paradermal section. The sinuses separating the lobes are rather pronounced, however they do not appear deep enough to warrant calling the lobes pinnules. Slender, unbranched, multicellular hairs similar to those borne on the petiole and pinna axes are found on the abaxial surface of the pinnules, both along the midrib and expanded portion (fig. 16). Most of the tissue of the pinnules is thin-walled parenchyma with sclerenchyma present as a sheath surrounding the midvein and larger lateral veins.

Sporangia.—Associated with the *Botryopteris* petioles and leaves are sterile sporangia similar to those reported by Graham (1935) (fig. 19). The wall is uniformly one cell thick with some of the cells filled with a dark mucilage-like material. In no case have these sporangia been found attached, but they occur isolated or clustered into groups. Also present, but in much smaller numbers, are isolated fertile sporangia, many of which contain spherical spores with numerous close, short, spiny projections (fig. 20).

DISCUSSION

In 1913 Bertrand published an account of the presumed method of petiolar branching of *B. forensis* (fig. 21A). Protoxylem is present as two "fundamental poles" at the tip of the median xylem arm. In addition other protoxylem groups are located at the tips and in patches along the outer flanks of the lateral xylem arms. The "fundamental poles" contribute protoxylem groups which migrate around the outer flanks of the lateral arms to the point where they depart with a portion of the metaxylem to form the lateral member.

Corsin in 1937 continued this hypothetical scheme with a series of diagrams showing the differentiation of the lateral trace into an ω -shaped strand (fig. 21B-F). He shows the lateral trace beginning first as a solid strand which becomes ω -shaped after splitting in two places. It must be emphasized



Figs. 8-10.—8. Transverse section of a petiole (p_1) and a secondary axis (p_2) at a level higher than that in fig. 7. The strand in the secondary axis has become ω -shaped. 9. Similar branching arising from the trace of the secondary axis. 10. A higher level after the strand of the tertiary axis (p_3) has assumed an ω shape. Axes p_1 and p_3 proceed nearly parallel to each other and perpendicular to p_2 . Magnifications of figs. 9 and 10 is the same as that for fig. 8.

here that this means of branching is entirely hypothetical and in no case is there any specimen to substantiate it.

Graham's *B. americana* (1935) was differentiated from *B. forensis* on the

basis of a different type of petiolar branching. He suggested that a portion of one of the lateral xylem arms separates and forms a miniature ω -shaped strand. This means of branching is essentially that described for the Berryville specimens, however only a single cross-section was illustrated by Graham in which one of the lateral arms was bent outward.

Darrah's reconstruction (1941) of the petiolar branching of *B. americana* does not correspond in any way to Graham's suggestion, but rather is based on Corsin's series of hypothetical diagrammatic cross-sections for *B. forensis*. Like Corsin, Darrah had no specimens to substantiate his reconstruction. The evidence presented from this coal-ball study would suggest that the type of petiolar branching described here is the typical one. In Corsin's work is a photograph of a single cross-section of a secondary petiole trace, one lateral arm of which is bent outward suggesting a similar mode of initiation of a lateral trace.

Further evidence that Corsin's scheme is in error is the fact that the *Botryopteris* petiole was compared to the rachis of *Anachoropteris*. He considered the only difference to be the lack of a median xylem arm in the trace of the latter. It must be agreed that this is a weak basis from which to postulate the origin of the botryopterid lateral traces.

If the previously described method of petiolar branching of *B. forensis* is to be discounted, then there is no anatomical basis for differentiating between it and the Berryville specimens. Furthermore, no sound distinction exists between *B. americana* and the specimens described herein. Such characters as the presence or absence of "fundamental poles," intraxylary sclerenchyma and cortical gum canals are rather weak characters on which to base specific differences since they may be largely influenced by types of preservation and portions of the plant involved. The identity of *B. forensis* and *B. americana* was earlier suggested by Corsin (1937).

A form which may tie in with *B. forensis*, *B. americana*, and the Berryville axes is *B. trisecta* Mamay and Andrews (1950). Since the stem and method of departure of the petioles are known to differ in *B. forensis* and *B. trisecta*, it would seem most suitable to retain these two specific entities. Only the basal portion of the petiole of *B. trisecta* is known and it is not inconceivable that the more distal portions are similar to those described in this paper. Mamay and Andrews suggested a size range for *B. trisecta* of from one to two decimeters in length. The plant which bore such axes as are present in the Berryville coal balls, however, must certainly have attained a greater height since the larger axes themselves exceed this estimate with few signs of tapering along their length.

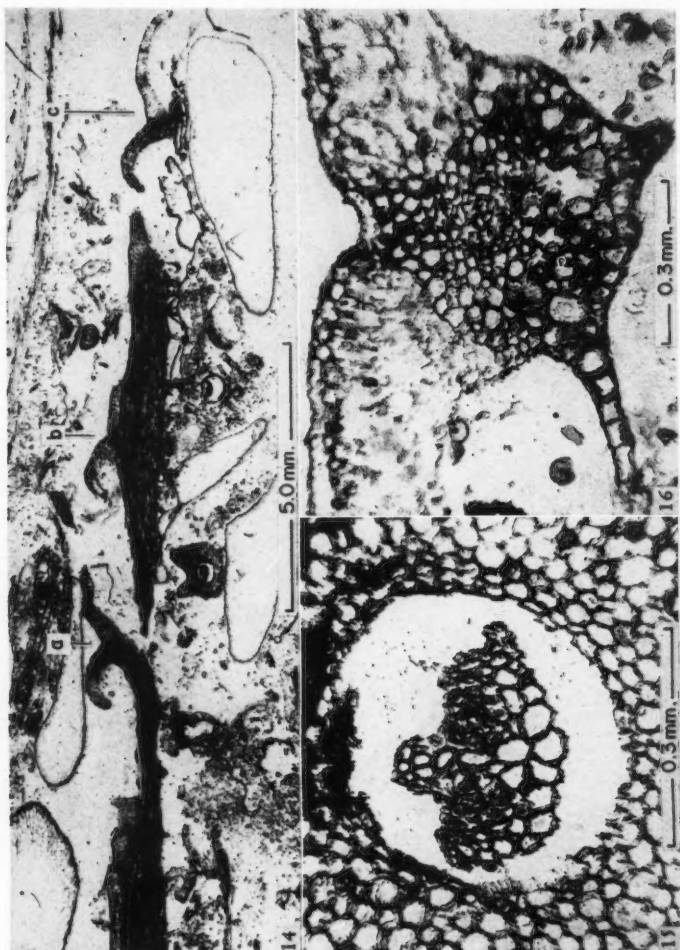
At other times in the history of the study of the genus, leaves have been suggested as belonging to *Botryopteris* (Renault, 1896; Kraentzel, 1934; Darrah, 1941). Renault and Kraentzel make no claim of actual organic connection. Renault illustrated a single pinnule and a coiled frond tip neither of which was assigned to any known form genus, while Miss Kraentzel showed only a single pinnule in cross-section. Darrah reports that pinnules in his material were actually attached to a *Botryopteris* pinna rachis. From his descriptions and illustrations it appears that there was confusion between *Myoxylon* and *Botryopteris* petioles in longitudinal section leaving the possi-



Figs. 11-13.—11. Transverse section of a smaller axis (p_4) after the departure of a lateral trace to the left of the larger trace. This method of trace formation is identical with that in larger axes. The smaller axis resulting from this division corresponds to p_5 in fig. 12. 12. Transverse section of a pinna (p_5) traversed by a small ω -shaped vascular strand and possessing two ridges on the adaxial surface. Attached to it is a pinnule. 13. Sections of the ultimate portions of the branching system. The portion indicated between the arrows indicates the length of a single lobed pinnule. The apparent inequality of the lobations is due to the obliqueness of the longitudinal section.

bility open that the pinnules which were compared to *Neuropteris rarinervis* were connected to the *Myeloxylon*.

Little significance was attached to these reports and as late as 1952 (Sur-



Figs. 14-16.—14. Longitudinal section of a pinnule-bearing pinna axis showing the origin of pinnules from the adaxial surface; a, b, c,—pinnules in transverse section. 15. Transverse section of the ω -shaped vascular trace of a pinna axis corresponding to p_5 in fig. 12. 16. Transverse section of a portion of a pinnule showing abaxial multicellular hairs.

ange, 1952), the general concept of the *Botryopteris* petiolar system was one of a telomic ramification. The usual concept of the transition from a telomic system to a fern frond involves planation beginning first at the ultimate segments, followed by a webbing. Such a condition is exemplified by the early



Figs. 17-20.—17. Cross-section of a single pinnule. 18. Longitudinal section parallel to the surface of a small portion of a pinnule showing the midvein (mv), and venation in a portion of a basal lobe of the pinnule. Although the pinnule does not appear to be attached to the pinna axis (p_5), the midvein is joined to it in the fourth peel of the series of which this photograph represents the first. 19. Sterile sporangia in association with the Berryville *Botryopteris*. 20. Fertile sporangium also in association.

Paleozoic form *Protopteridium* in which only the distal telomes have been involved in webbing. Some species of *Botryopteris* have progressed to a state in which the ultimate portions are frond-like in all respects, while the lower axes retain the primitive character of three-dimensional ramification (fig. 22).

The present study will perhaps serve to stress the need to reexamine many of the compression forms as well as much of the non-fertile foliage occurring in petrifications. It further complicates the problem of differentiation among types of compression foliage by the addition of a third member to the fern-pteridosperm complex.

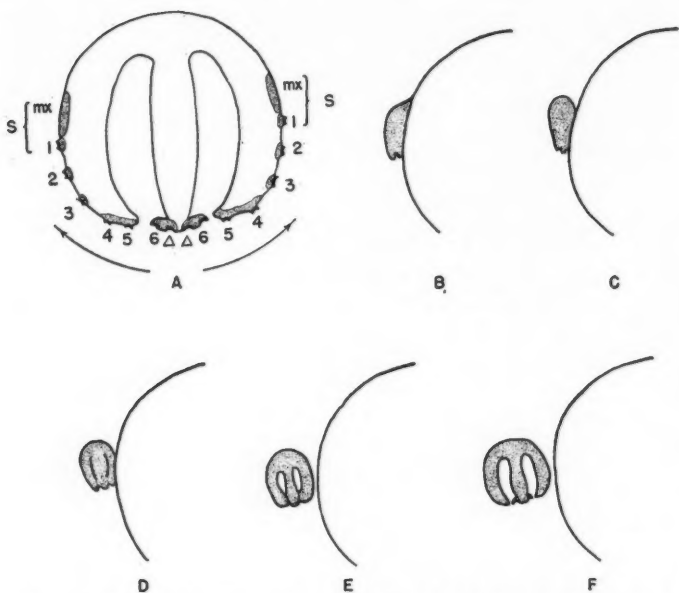


Fig. 21.—Hypothetical method of petiolar branching of *Botryopteris forensis* as postulated by Bertrand (1913) and Corsin (1937). Adapted from these authors

In addition the discovery of *Botryopteris* foliage necessitates the reexamination of the genus with respect to gross aspects of the plants and of their phylogenetic importance. Many workers (e.g. Mamay and Andrews, 1950; Surange, 1952) have emphasized the relative undifferentiation of the plants in their lower portions and the difficulty in determining the exact morphological nature of these axes. This argument has been used to place the coenopterids, especially *Botryopteris*, in a position transitional between the Psilophytales and true ferns. The Berryville specimens duplicate this "primitive character" to some extent in the three-dimensional branching of the petiolar axes, but in their ultimate regions there can be no question of their morphological category since pinnule-bearing members are arranged in one plane. With this information the growth habit of at least some of the species might be conceived of as a bush-like structure irregularly branched below with distal portions possessing flattened frond-like members. To be sure, our present knowledge of some of the other forms such as *B. cylindrica* and *B. antiqua* would make it difficult to suggest the same type of growth habit for them.

In spite of the relatively unspecialized nature of these plants in their basal regions, this character used alone is indeed an uncertain basis to support the phyletic origin of true ferns from the Coenopteridales. If vascular pitting is to have any significance in determining plant phylogeny, it would be difficult to place the Coenopteridales in a direct line leading to ferns since in most

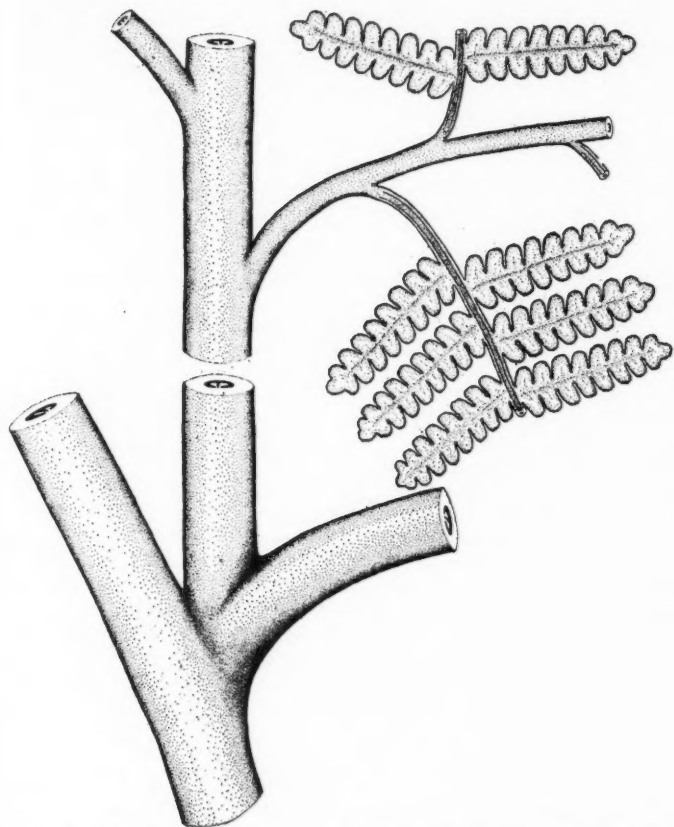


Fig. 22.—Suggested reconstruction of a portion of the petiolar and frond system of a member of the genus *Botryopteris*

members the nature of the pitting is more advanced than the simple scalariform type of most ferns. In some cases, even in such a supposedly primitive type as *Botryopteris*, pitting attains an alternate multiseriate circular bordered arrangement. To be sure, members of the Ophioglossales possess circular bordered pits, but Eames (1936) suggests that this group is specialized and very probably gave rise to neither of the other two orders of ferns.

A further point against deriving modern fern members from the Coenopteridales is the existence in Paleozoic times of an abundance of the tree fern *Psaronius*. There can certainly be no doubt that the lateral, photosynthetic appendages of these forms are true fern fronds constructed in a single plane. Thus it would seem that the transition from the primitive branching system

to a true fern frond had been completed very early in the Paleozoic. *Botryopteris* and the other coenopterids, although possessing persistent primitive features, may be considered an aberrant group with no obvious direct descendants.

Another argument for placing the Botryopteridaceae in a primitive position is the possession of a supposedly simple type of sporangium. In general they are ellipsoidal or spherical bodies the walls of which are composed of a layer only one or two cells in thickness. The sporangia are borne on branching axes. If the eusporangiate condition, as first exemplified by the Psilophytales, is to be considered the more primitive type, the thin-walled sporangia of *Botryopteris* (apparently only one cell thick in some forms) and other coenopterids (e.g. *Etapteris*) could hardly be placed low in filicinean phylogeny.

The description of an American member of the genus *Botryopteris* presented in this paper may perhaps be used to stress an often neglected principle of plant evolution. It has been recognized that the rate of evolution of plant organs or parts of organs may vary considerably. At least certain members of the genus *Botryopteris* retain persistent primitive features, e.g. relatively undifferentiated three-dimensional branching in their lower portions, while in other features occupying a relatively advanced position, e.g. multiseriate circular bordered pits, thin-walled sporangia probably reduced from forms possessing thick-walled structures, and frond-like ultimate segments. It would then be unwise to place *Botryopteris* in any single phyletic position without taking into consideration the total combination of characters involved.

The views in this paper may not prove to be the most feasible ones with regard to the phylogenetic position of *Botryopteris*, but unless such features as pitting and sporangial characters are completely disregarded, or unless there is a revision of their value in determining phylogeny, previously existing ideas of the position of the genus may be questioned. Even if the present views are not the most logical ones, they will perhaps serve to stimulate many modern morphologists out of the lethargy of clinging to time-worn ideas backed only by sentiment and not by morphological facts.

SUMMARY

A description of the petiolar branching and of the frond-like nature of the ultimate segments of an American member of the genus *Botryopteris* has been presented.

Lateral traces arise from the ω -shaped petiolar or pinna traces by the separation of a portion of one of the lateral arms which in turn becomes trident. This type of branching continues even to the ultimate pinnule-bearing pinnae.

Pinnules are borne on pinnae characterized by two longitudinally extending ridges on the adaxial surface. The pinnules which may exceed 1.5 cm in length are lobed and possess slender multicellular hairs on the abaxial face.

Unattached sterile and fertile sporangia are found in association with petiole and leaf material.

Since the method of petiolar branching of *B. forensis* as suggested by earlier writers is very probably in error, no significant anatomical distinction can be made among *B. forensis*, *B. americana*, and the specimens described in this paper.

The presence of leaves on at least one member of the genus *Botryopteris* is a relatively advanced feature in contrast to the three-dimensional branching of

the lower portions of the petiole. This condition can be derived from a telomic branching system and may be considered transitional between such a condition and an essentially two-dimensional fern frond. This character used alone, however, is not enough evidence to derive the ferns from the Coenopteridales.

ACKNOWLEDGEMENTS

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A Remarkable New Mammal From the Lower Chadron of Nebraska

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Agate, Nebraska

While we were examining an unusually fossiliferous exposure in the lower member of the White River beds near Whitney, Dawes County, Nebraska, my wife, Mrs. Margaret C. Cook, discovered tiny, scattered fragments of a lower jaw on the surface of the gray-green member of the Chadron formation. While screening the dry surface, using binocular glasses and working into the matrix, she found an articulated skull and cervical vertebrae under where the jaws had weathered out. Near the skull were several disarticulated vertebrae and ribs. These remains were removed in one block.

Preparation has been difficult, both because of the nature and condition of the fossils and matrix, and because slippage in seams of the clay-silt matrix has caused many fractures and dislocations. Though the skull is virtually complete, the facial region from the orbits forward has been compressed laterally and twisted to one side. The maxillae and teeth are intact, but much remains to be done before the characters of the skull can be fully determined. The vertebrae also are to be prepared. They appear to be very large and heavy in proportion to the skull.

Meanwhile, many of the tiny fragments of the lower jaws and teeth have been fitted together, revealing dentition that is complete except for the lower incisors. The specimen indicates a mammal that is surprisingly primitive for its horizon in the Tertiary, with characters reminiscent of Paleocene and early Eocene mammals. Several of these characters are either homologous with or analogous to those of early creodonts, insectivores and artiodactyls.

For the present I am referring the creature to the creodonts, though it does not seem to be closely related to any creodont of later than early Eocene age with which I have compared it. A partial summary of these comparisons is presented in the following description.

Suborder CREODONTA

Family MESONYCHIDAE (?)

Chadronia margaretae, gen. et sp. nov.*

Type: HC 750, Cook Museum of Natural History; skull, jaws and articulated cervical vertebrae and some dorsal vertebrae, and ribs, not yet freed from matrix.

Dental formula: $M \frac{3}{3}$, $P \frac{4}{4}$, $C \frac{1}{1}$, $I \frac{2}{2}$

Generic characters: No carnassials, upper molars triangular and tritubercular. Lower molars with two high anterior cusps (protoconid and metaconid); paraconid absent; talonid with entoconid and hypoconid low and strong. Premolars high, pointed and relatively simple both above and below. Deuterocone on P^4 nearly medial. Canines large and recurved. Two incisors above, number below unknown.

MEASUREMENTS

	mm.
Total length of skull, occipital condyles to tip of premaxillae (approximate)	151
Length of molar-premolar series	40

* The species is named for my wife, who found the type specimen, has helped with the preparation, and has made the line drawings.

Length of molar series	16
Length of molar-to-incisor series (approximate)	71
Depth of skull, occipital crest to base of condyles	38

The skull is long, low and narrow, with a vestigial sagittal crest unlike the crest in carnivorous marsupials. Occiput flares and is low; extending backward and outward, it suggests a powerful neck in keeping with the relatively large cervicals.

The brain is small, the facial portion of the skull (from the post-orbital constriction to premaxillae) is about one-third longer than the portion behind it. The low, long, relatively straight-topped profile of the skull differs greatly from the high sagittal crest and sharply curved profile of *Triisodon*; or of *Mesonyx*, and related genera. Zygomatic arches of moderate size. The basicranial region, from the glenoid fossa to occipital condyles, is relatively longer than that of *Mesonyx*.

No tympanic bullae are preserved. They probably were incompletely ossified, if present, and may have been loosely attached, as in insectivores and marsupials. In most, if not all more advanced carnivores they are well ossified and fastened to the skull. However, as the hyoid arch was present and approximately in position, it seems unlikely that if tympanic bullae had been present they would have been lost, and the hyoid arch units preserved, in place.

Glenoid fossa wide and shallow, with short post-glenoid processes. Muzzle deep, with nasal bones extending well forward. Premaxillae extend far backward parallel to the curved, long, heavy root of the canine, and so have long contacts with the nasals. Infra-orbital foramen very large.

The upper molars are triangular, with tubercular paracone and metacone. The partially worn protocone appears to be crescentic rather than tubercular, and so is reminiscent of the protocone in *Anaptomorphus* and in *Triisodon*. A strong cingulum extends around the inner side of M^3 ; it is thinned on the

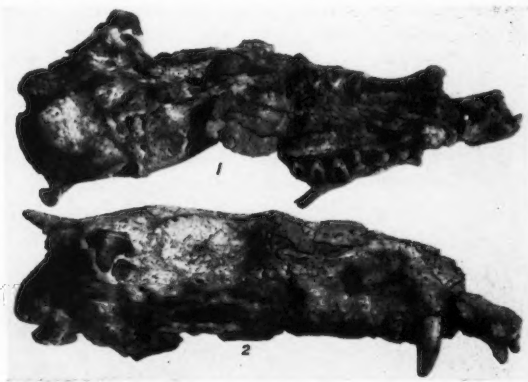


Fig. 1. —*Chadronia margaretae*, Type. Palatal view. $\times 1/2$. The left maxilla, as shown in this photo is only approximately in place, and is not attached to the skull. The left canine, parts of both zygomatic arches, and other parts which are present, but not yet assembled and fitted, will make this an almost complete skull. Fig. 2. —*Chadronia margaretae*, Type. Right side of skull, $\times 1/2$. (Charles D. Downey photos)

inner side of the protocone on M^2 ; and is interrupted there in M^1 . This cingulum is expanded postero-internally on all three molars, to a greater degree than it is in such a primitive creodont as *Triisodon*; but there is no trace of the cingulum on the outside of the molars, where it is thick in *Triisodon*. The parastyle is absent.

The molars become smaller from M^1 to M^3 , and are progressively more oblique, on their external borders. P^4 is relatively large, with a large, medial deutocone, as in the Ursidae. It is always *anterior* in the Canidae. P^3 is subtriangular, trenchant and heavy. P^1 and P^2 are trenchant and strong, double-rooted. P^1 lies against the base of the large canine and is slightly reduced in size. Upper canine heavy, strong and recurved, and had slight anterior and posterior *keels*. It was flattened internally by friction against the lower canine. The latter is very large and heavy in relation to the size of jaw, and was so strongly recurved that it required a wide space in front of the upper canine to permit it to function as the mouth was closed. This necessitated relatively long premaxillae and reduced the space available for upper incisors, which are reduced to two on each side. The second incisor is larger than the first, but both are relatively large and strong and have a slight forward slant. The characters from canines forward noted here differ to a marked degree from those in anything to which it might be related, with which I am acquainted.

Though they differ in many details, both the upper and the lower molar-premolar series show a marked general resemblance to the dentition in the Paleocene *Tricentes*.

The lower jaw is rounded and heavy, with a strong and extra broad and high coronoid process and a very long and heavy protruding angle on the jaw, indicating heavy muscles.

The lower molars have two high, transversely placed, anterior cusps, the protoconid and metaconid; and the paraconid is completely absent, in sharp contrast to the conditions found in all canids, felids, mustelids, raccoons and viverrids, and some creodonts; and more comparable to the condition found in some primitive artiodactyls. The talonid is low, but strong, and slightly expanded, with the hypoconid somewhat larger than the entoconid. The lower molars become smaller from M^1 to M^3 , as do the upper molars, and all have two heavy roots. P^4 is large and high-crowned, with a small keel and tiny

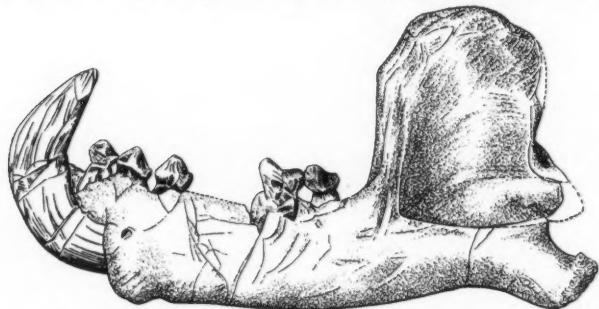


Fig. 3.—*Chadronia margaretae*, Type. Left lower jaw, side view.

cingulum across the anterior end. P_3 is very robust. P_1 and P_2 are well developed, with characters agreeing with the posterior premolars, but smaller; all with two roots. The similarity between these lower molar and premolar teeth, and those in the primitive artiodactyl *Wasatchia*, is striking.

Likewise, compared with the Oligocene *Leptochoerus*, we again see striking similarity or convergence of characters, in the cheek dentition, in contrast to the divergence in other characters.

As compared with *Stibarus* analogies are again noticeable in the molar-premolar dentition, but P_3 differs most widely. In *Stibarus* this is a rather long, narrow tooth with three low cusps in line. In *Chadronia* it is tall, compressed antero-posteriorly, thick and heavy, with a single big cusp dominating a vestigial heel. *Chadronia* is larger and heavier than these latter genera.

In *Chadronia* the lower canine is very large, long and heavy and is strongly recurved. It locked into a recess in the upper maxilla, in front of the upper canine, comparable to the condition found in peccaries.

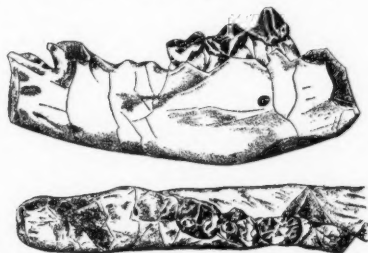
Some of the many tiny scraps, found in the surface screenings, may pertain to the front end of the lower jaws, and it is possible that more of this can eventually be fitted together. At least one lower incisor was present.

The absence of a paraconid in the molars and absence of sectorial or carnassial adaptation in the dentition, limits the probable relationships of *Chadronia*.

Among the Creodonta it is clearly distinguished from the Arctocyoniidae, which have quadritubercular molars; from the Proviverridae, which have a trigonid; from the Paleonictidae, which have reduced dentition; from the Hyenodontidae and Miacidae, which have sectorial teeth. In the Oxyclaenidae the molars are essentially quadrate, and the fourth premolar is molariform, thus contrasting sharply with that of *Chadronia*.

Chadronia appears to be most nearly related to Mesonychidae, among the Creodonta, though it differs widely from *Mesonyx*. It would be premature to attempt to fix its relationships more definitely until more complete studies can be made.

Many authorities have observed that characters of some of the primitive Creodonta suggest relationships to primitive insectivora and to some primitive primates. It is surprising to find a creature as primitive as *Chadronia* in the Oligocene, with no hint of probable ancestors later than early Eocene. Assignment of this genus to the Mesonychidae, therefore, is tentative.



Figs. 4-5.—*Chadronia margetae*, Type.—4. Right lower jaw, side view; 5. Crown view of teeth. $\times 1$.

Some Observations on Moose in Yellowstone Park

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The observations presented in this paper are based on a study carried out in Yellowstone Park during the summers of 1947, 1948, and 1949. The two areas within the park covered intensively were: 1. Swan Lake Flat-Willow Park area, covering approximately five square miles, lying in a general north-south direction paralleling the main park highway midway between Mammoth Hot Springs and Norris Geyser Basin. 2. Pelican Creek valley leading off northeasterly from the north side of Yellowstone Lake and embracing about two square miles. Both of these areas have high moose populations during most of the year. Willow Park and Pelican Creek areas are covered with dense willow growth which furnishes approximately ninety per cent of the summer food of moose. Swan Lake Flat is an open expanse supporting grasses, sedges, and aquatic plants which are utilized as food.

Moose in Yellowstone (*Alces americana shirasi* Nelson) have excited considerable interest since Shiras (1913) made the initial study. Seton (1929) concerned himself primarily with *Alces a. americana* (Clinton), as did Murie (1934) in his ecological study of the moose of Isle Royale. A special set of conditions obtain, however, in the ecology of any species in Yellowstone Park because of over-crowding of elk, bison, antelope, etc., on a limited range and also because of the tourist pressure which has been increasing tremendously since 1946. This paper, covering only some of the more general aspects of behavior, is a part of a larger study of the general ecology of moose of Yellowstone with particular reference to summer food habits. Such a study of the moose of Yellowstone was necessary because of the special conditions imposed by sanctuary within the park and because it has become apparent that much of the information regarding a particular species in one section of the country does not apply wholly to the same species or closely related species in other sections.

Direct field observations were made using 7 x 35 mm binoculars to obtain the data presented. Individual moose were given a number as soon as their distinguishing characteristics were learned, i.e., sex, size and shape of the bell (if present), color, presence of scars, size and form of antlers on the bulls, etc. For example, the first moose positively identified in 1947 was given the number, 7-1; the second animal identified in 1948 was numbered 8-2, etc.

General behavior.—The Willow Park-Swan Lake area was the primary area selected for intensive study and was subject to heavy tourist pressure. In order to learn whether the moose of that area become conditioned and react differently to human interference than those in an area which is isolated from tourists, the Pelican Creek area was selected for comparison.

The valley of Pelican Creek is ideal moose habitat and the moose population is perhaps only a little less dense than in the Willow Park-Swan Lake

* Extracted from a thesis presented to the Graduate Faculty, University of Michigan in partial fulfillment of the requirements for the degree of Doctor of Philosophy.

area. The two regions are comparable in every respect except in the degree of accessibility to tourists. Willow Park lies adjacent to the main highway and daily during the tourist season hundreds of people stop to photograph the moose at as close range as possible. The moose of Pelican Creek are rarely molested, and then only in the lower part of the valley.

Each year when field work began in Willow Park the moose exhibited a wariness at my approach that disappeared after repeated approaches. With those moose that were observed frequently and for long periods, a slow, quiet approach could be made to within twenty-five to fifty yards with no difficulty after several weeks on the area. The activity of the animal at the time of approach determined to some extent how close I could get before it became alarmed. If the moose were feeding in the willow flat twenty-five yards was about as close as I could get to them. As they moved about feeding I could walk along with them without causing alarm. If I sat down while observing them feeding they would feed closer to me than if I were standing. In one instance a mature cow fed up to within fifteen feet of me while I sat at the edge of the clump in which she was browsing. She moved off a short distance when I stood up.

If a moose was feeding in the water on aquatic plants it was much more wary of a close approach regardless of how frequently that same animal had been observed. It appeared as if they sensed the difficulty of movement in the soft bottom of the stream bed. Similarly, if the disturbing factor appeared between them and the avenue of escape they were much more wary than if the way to protective cover was not cut off.

In most instances where a moose was frightened sufficiently to run it ran for the protective cover of the woods. When forced to flee while in the timber they would run only far enough to get out of sight. The moose depends upon cover rather than speed for protection and in this respect differs from the antelope and to some extent from the elk. Cows with young calves tend to hold to cover much longer before being flushed than barren cows and bulls.

Moose in Willow Park seem to be less easily frightened when lying down than when feeding, especially after they have been bedded for half an hour or more. In many instances I had both bulls and cows under observation for several hours at a range of twenty-five to sixty feet while they were bedded down. Slow, quiet movement did not cause alarm although they were alert.

I believe that some of the animals observed frequently, and at close range, learned to recognize me. In order to make sure that it was not just the manner of approach that made a close approach possible I selected four mature moose, two bulls and two cows, which had been observed most frequently in Willow Park for a test, by having two other men, who had been with me in the field and knew my manner of stalking the moose, approach each animal at different times. This was done late in the summer of 1949 after the selected animals had become thoroughly accustomed to me and allowed an approach to within twenty-five to fifty yards without exhibiting nervousness. The moose were approached separately by each man independently. The approaches were made while the moose were feeding and also while they were resting. Each of the four moose was observed twice by each man. The observations were made on different days to be sure that the animal was not annoyed from the previous experience. The manner of approach was slow and quiet. Ordinary rough

field clothes with no conspicuous colors were worn. Observations were taken on the distance at which the moose became aware of the person approaching, the response made, the minimum distance tolerated before moving away, and the manner of moving away. Many observations were made of tourists who attempted to get close to these same moose.

The experiment indicated the following: a. The closeness of approach is dependent on the manner of approach primarily. The slow, quiet approach enables the observer to get much closer and causes less concern in the moose than a fast, noisy approach. b. Some moose apparently are able to recognize an individual. In every instance, except one when the bull under observation had been frightened by tourists earlier in the day, the familiar person was able to approach 50 per cent closer than the two unfamiliar persons before moving off. The average minimum distance for the unfamiliar men was sixty yards while for the known individual that distance was thirty yards. c. The distance at which the moose became aware of the approaching person was dependent on how far it could see the person and not on who the person was. The direction from which the approach was made had no apparent significance nor did the direction from which the wind was blowing. d. The type of response made by each moose, when the person was observed at a distance of one hundred yards or more, was one of intent watching. After watching intently for a period varying from a few seconds to several minutes, feeding was resumed or the moose moved off. The moose in the Pelican Creek area generally ran for protective cover when disturbed while those in the Willow Park-Swan Lake area moved off slowly, feeding as they went. e. A closer approach could be made to the moose of Willow Park-Swan Lake when they were bedded than when feeding, especially if they could see the approaching person. Moose of the Pelican Creek area were intolerant of approach under both conditions.

At no time was I able to get closer than one hundred fifty yards to the moose of Pelican Creek if they were feeding in the open flats. This was also true of moose observed in the isolated Heart Lake regions of the park. They did not detect me at any greater distance than those used to human intrusion, but when aware of the approach they displayed greater nervousness by not feeding, by milling around, and by taking flight more readily. The same behavior was shown by those moose bedded down in the timber. When seen in the woods it was at relatively close range and they took flight quickly, which is in direct contrast to those of Willow Park.

The two groups of moose showed a striking difference also in the length of time that they remained away from the feeding grounds when frightened off and in the length of the period in which they maintained an attitude of wariness. Those in Pelican Creek would generally not be seen again the same day if frightened from the feeding grounds. This was rarely true of those in Willow Park.

Response to sounds.—The response of the moose to various sounds is particularly striking. They showed a very quick response to the snapping of twigs or rustling through brush by ceasing to browse or by getting up immediately, if lying down. The metallic click of the field notebook would invariably bring a quick response and so would the snapping of a stick even though I were sitting down and the moose had had me under observation for some time and had become reconciled to my presence, whereas speaking normally, shouting, or a

sharp whistle failed to produce any response. However, if noise and movement were associated the animal became nervous and frightened.

In most instances when alarmed the moose would stop to survey the situation before running. If aroused suddenly from a copse at close range the animal would make a wild dash for a short distance and then stop to look, and if it were a cow, pinch its hind legs together and urinate before continuing to run.

Sounding of automobile horns, backfiring of engines and other sounds coming from the highway failed to produce any response in the Willow Park moose. This alone indicates that moose become accustomed to certain disturbing factors and make no response so long as they are not harmed.

Voice.—Moose, at least during the time other than the breeding season, are decidedly non-communicative. On only two occasions in three summers of field work did I observe communication between cow and calf. On June 30, 1947, a cow and calf were feeding on willows within fifty yards of the highway. Soon a dozen or more cars had stopped and people were standing on the highway observing the moose. The calf was quite playful, running around the cow and kicking up its heels like a domestic calf. The cow was obviously nervous because of the human intrusion and she gave two sharp barking sounds that could be heard two hundred yards. This immediately brought the calf to her side and all play ceased.

Another similar instance occurred when the cow was feeding in Obsidian Creek and the calf was frisking about on the bank. As the crowd of tourists started to gather, the cow left the bed and gave the barking sound which brought the calf to her and both went off through the woods.

On one occasion an old bull was following a cow through the timber making a low, soft, noise, the first part of which was a whine, but ending in a grunt. The duration of the sound was one or two seconds. It was heard repeated fifteen to twenty times in a five minute interval. The cow responded with a low whine when the bull approached her and smelled her genitalia. Seton (1929) mentions this "whine of desire" on the part of the bulls. This is believed to be an early manifestation of the approaching rut because it occurred August 29, 1947. In the following year, August 18, 1948, a similar incident was observed. The rutting season is in full force from about mid-September to the latter part of October.

A mature cow that had been flushed from a willow copse at close range gave the only indication that the voice is used when frightened. She was flushed at a distance of twenty-five yards. After running about fifty yards she stopped, turned, looked intently for several seconds, pinched her hind legs together and urinated on them, then gave a short, deep-pitched bark that could be heard for a quarter of a mile and fled toward the heavy timber on a fast trot. After she reached the protective cover she made the same sound twice in rapid succession, then was seen and heard no more.

A calf that was lost from its mother ran back and forth through the willows searching and repeatedly gave a high pitched squeal of one second duration.

Play.—The moose is a decidedly undemonstrative animal and only rarely indulges in play. In this respect it differs considerably from the bighorn sheep and pronghorn antelope, both of which frequently indulge in carefree sparring with a partner.

Bulls with antlers still in velvet were seen to spar back and forth on several occasions, but only for a few seconds each time. Extreme care was taken not to apply pressure to the growing antlers. On another occasion two yearling cows were approaching the willow flat to feed when they stopped and made several feints at each other and then ran off a few yards at a gallop and the play ended.

Movement.—The normal gaits of the moose are the walk, and the trot. I have seen them gallop only rarely and then only for a short distance. It appears to be a labored effort and is indulged in playfully rather than in fright. The gait used to cover ground rapidly is the trot. It was not possible to check the speed, but I believe that a moose can easily out-distance the average horse at a trot. This would certainly be true if the horse were forced to run on the marshy ground frequented by the moose. Seton (1929) says he believes fifteen miles per hour is the average speed. Because of the type of habitat it has not been possible to measure the speed of moose as Einarsen (1948) did for the pronghorn antelope.

In normal walking on the marshy ground the length of stride ranged from twenty-one to thirty-four inches for an average size bull. On a fast trot the length of stride ranged from forty-five to fifty-three inches for the same bull.

Daily cycle of activity.—In order to learn about the habits of moose in detail a record was kept on each of the recognized animals that had been designated by a number. As opportunity presented itself these individuals were observed for as long as six hours in some instances and detailed notes taken on their behavior. The following data are taken from the field notes of July 7, 1948, and show the continuous activities of cow 8-4. They are chosen as a typical picture of moose behavior as observed during daylight hours.

9:25 A.M. First observed coming toward woods from Willow Park where, presumably, she had been feeding.

9:30 A.M. Bedded down about thirty yards back from edge of woods. Detected me; got up; watched intently five minutes.

9:35 A.M. Feeding. Moved out to edge of willow flat. Feeding on *S. Wolfii*. Height of willow, two feet. Behavior indicates she is aware that she is being watched. Looks intently in my direction after a few mouthfuls. Seems not to be alarmed.

10:05 A.M. Bedded down in woods again near same spot as before. Nipped at *Poa* and *Agropyron* on two occasions as she proceeded to bedding spot. Flies very bad today. Twice she ran briskly ten or fifteen feet, apparently to get away from flies. Backs of hind legs just above the hocks are covered with flies.

10:14 A.M. Still bedded. Fighting flies constantly with ears. Occasionally is alerted by noise coming from highway. She is approximately 400 yards from highway with a narrow strip of intervening woods. She is fifty yards from me.

10:30 A.M. Still bedded. She is panting moderately. It is warm today, but not hot. Estimated temperature, 80 deg. F. She is lying in partial shade. Panting at the following rates per minute: 54—50—48—54—54. Panting ceases when alerted or moving. Have observed panting only in resting moose.

10:40 A.M. Still bedded. Wind coming up. Insects not quite so bad because of it.

11:57 A.M. Still bedded. Started chewing cud after resting 1 hr. and 52 min.

12:20 P.M. Still bedded. Has been nipping *Agropyron* while still lying down. Fed that way for two minutes.

12:24 P.M. Up and feeding. Has been lying down for 2 hrs. and 19 min. Have observed previously that when the moose starts to feed while still lying down that they soon will get up. Indicates restlessness and hunger, perhaps. Feeding on *Carex*, *Poa*, and *Agropyron*. Seems to take the grasses in preference to the sedge.

12:27 P.M. Defecated. Seems to be a routine procedure soon after getting up.

12:32 P.M. Moving out to willow flats. Pulled up entire plant of *Potentilla* sp. and ate it.

12:36 P.M. Defecated; second time in nine minutes. Half a dozen big flies (tabanids?) on the inside of right hind leg just above the ankle or "hock" joint. Small flies clustered around the tabanids, apparently to get any excess escaping blood. No effort made by the cow to rid herself of the flies.

12:40 P.M. Urinated; first since getting up.

12:50 P.M. Moved back into clump of timber (lodge pole pine, spruce, and fir) and lay down immediately at foot of spruce tree in the shade. Had fed for 23 min. In moving back into the woods she came to within 20 yds. of me. She was aware of my presence. Seemed to exhibit no fear or nervousness. Lying down about 30 yards from me.

2:30 P.M. Got up because I frightened her. I had left the area to observe another moose some distance away. I came back to resume observation on cow 8-4 expecting her to be still bedded in same spot as when I left her. Some time during my absence she moved to a new bed. Reason, unknown.

2:32 P.M. Watched intently for a minute. Moving off slowly. Going to willow flats. Not feeding.

2:35 P.M. On willow flats feeding on *S. Wolfii*. Height of willows 2-3 ft.

2:48 P.M. Drinking in small, sluggish feeder stream of Obsidian Creek. Drank intermittently for 2 min. Drank while standing in the stream. Did not feed while in stream. No aquatic plants there.

2:50 P.M. Left canal. Feeding on *S. Wolfii*.

3:15 P.M. Still feeding. Appears to feed equally on both *S. Wolfii* and *S. Geyeriana*. *S. Wolfii* low, 2-3 ft. high; *S. Geyeriana* 3-6 ft. high. She has been browsing at 2 ft. level all the way up to 6 ft.

3:25 P.M. Fed in same area, about 10 x 10 yds., for 35 min. Running on fast trot. I think she is trying to get away from flies. As far as I can tell nothing frightened her to cause her to run away. This has been the worst day so far this season for flies. Cow ran about 100 yards north.

3:27 P.M. Entered clump of *S. Geyeriana*. Diameter of clump about 15 yds. Height of willows 6-12 ft.

3:30 P.M. Still in clump. I left the area. No further observations.

Moose tend to have a fairly rigid pattern of daily activity, consisting of alternate feeding and resting. The first feeding period of the day for the majority of moose begins around 5 A.M. A delay in commencing to feed is frequently noticed, however, until the fog, which is quite common in the early morning on the study area, has lifted somewhat.

There appears to be a performance for bedding down in the spruce-pine woods on the ridge bounding the west side of the feeding grounds. The moose come directly from their beds of the previous night to the feeding grounds without hesitation and begin to feed immediately.

The maximum number of moose may be observed feeding in the interval from 7 to 9 A.M. After that the number steadily declines until around 1 P.M., at which time most of them are bedded down again. Soon thereafter, a few animals commence feeding for a short while. Presumably these animals are the ones that bedded earlier in the morning. The peak of activity in this second period of feeding is about 2 P.M. On cool, cloudy days more moose come out to feed at this time than when it is hot and the sun is bright. This mid-day peak is less than one-half as great as the two major peaks of the day. From about 2 or 3 P.M. until around 4 or 5 P.M. most of the moose are again bedded down.

Between 4 and 5 P.M. they again begin to feed. The maximum number is observed from 7 to 10 P.M. Few observations were made between 10 P.M. and 5 A.M., but there appears to be a steady decline in number of feeding moose from around 9 P.M. Another reason for believing this is that each of the other peaks on the curve of figure 1 has a fairly uniform increase and

decline and there is no apparent reason why this portion of the daily cycle would be any different.

The resting periods during the day ranged from twenty-five minutes to 6.5 hours with a mean of 3.0 hours and if we assume that the resting periods from midnight on would be approximately the same, then I think it safe to assume that the right end of the curve of figure 1 is within bounds of reasonable accuracy.

Figure 1 shows the two major peaks of feeding activity in the morning and evening with the minor peak shortly after mid-day. The morning and evening periods are of approximately four and six hours duration, respectively. The low points in the curve indicate the times when the greatest number of moose are resting. In general this cycle of activity corresponds to that observed by Murie (1934) in his study of the Isle Royale moose.

There is no apparent difference in the number of moose bedding down for the mid-day siesta in the willow flats and in the woods. Those in the willow flats almost invariably select a clump of willows that hides them from view completely or else they choose to lie with their backs at the edge of a clump and a full view ahead and to the sides. In most instances the willows hide them from the side where tourists can see and approach them. In the early part of the season, before tourist pressure reaches a high peak, a few instances have been observed of moose bedding down in the open, unprotected sedge. There is no evidence that individuals, except cows with very young calves, go to the same willow clump day after day to bed down.

The same animal may one day bed in the willows and the next day go to the woods. The same bedding areas and bed forms in the woods are used repeatedly by the same animal. In feeding, the moose gradually works its way to the edge of the woods. From there the movement to the favorite bedding spot is generally slow and deliberate. All of the established bedding areas are

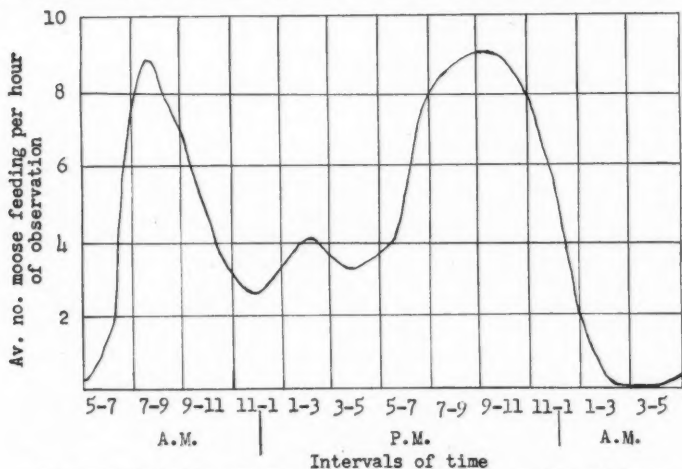


Fig. 1.—Daily feeding cycle of moose based on 1,847 sight records in 508 hours of observation during summers of 1947-48-49.

within 250 yards of the edge of the woods. The time between entrance into the woods and bedding down varies from five to forty-five minutes. If the animal is frightened from the feeding grounds it remains alert for a longer period than it does otherwise.

Upon lying down the moose remains quite alert for half an hour or so. Frequently, if I took up, in this interval, a position for observation where the animal could see me, it would get up and select another bed. The bulls appear to be more cautious than the cows in this respect. After having been bedded for more than half an hour the moose seem to resent intrusion less and are not so wary. After lying down for a period varying from thirty minutes to as much as three or four hours they begin to chew their cuds. They continue chewing until they get up to feed again.

From time to time they lay their heads back on their sides resting the muzzle on the flanks, often closing their eyes and dozing for several minutes. The slightest unfamiliar noise, however, alerts them. After lying on one side for several hours they may get up, stretch, and lie down again on the opposite side.

An indication that they will soon get up is the apparently restful stretching of the neck and legs. The neck and head are frequently stretched full length with the muzzle pointing upward at a forty-five degree angle. All four legs may be extended full length to one side. One or both front legs may be extended straight forward in the manner of a dog.

Very often two animals that have been feeding together will leave the willow flats at the same time and select a bedding spot in the woods within twenty-five yards of each other. It appears that moose are influenced by the behavior pattern of near-by individuals to some extent. When one lies down others follow suit; when one gets up, others within a range of several hundred feet may do likewise. In this respect they resemble cattle and sheep.

The bed forms that are used repeatedly are generally located in an area with considerable fallen timber. A favorite spot seems to be behind a windfall which conceals them from at least one side with a clear avenue of escape to another. All beds seen were located so that a quick "get away" would be easy.

After coming in from the willow flats, if they do not go to a well-established bedding spot, they bed down only after some deliberation and careful selection of a suitable spot. The frequently utilized beds acquire a very characteristic odor, pungent, but not unpleasant, somewhat like a mixture of weak lysol and iodoform mingled with a barnyard odor. This was particularly pronounced in two beds where cows had calved and remained for a week or more. Frequently the well-established bedding grounds can be located by odor before being sighted. The reason for this characteristic smell is not known. Possibly the decomposition of the urine is the cause. The bed forms are not fouled by the excreta but the surrounding area may be.

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Aberrant Coloration in *Tadarida Mexicana**

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There seem to be no records of color aberrations in the genus *Tadarida*. Allen (1940) stated that both melanism and albinism are rare in bats, then cited the few instances known to him. Setzer (1950) listed nine genera with known cases of albinism in his brief review of the subject. To this list may be added the Mexican free-tailed bat, *Tadarida mexicana*, on the basis of numerous instances of albinism reported herewith.

According to Anthony (1928) the color of *T. mexicana* is "upperparts uniform warm brown, near bister brown, -----underparts lighter than upperparts and with more yellow." Other authors agree with this description, adding that the hair of the back and neck is white at the base.

On several occasions between 1947 and 1952 the writer has visited two of the many gypsum caves, in western Oklahoma, that harbor colonies of these bats. One of these is in northern Woodward County among the bluffs on the west side of Bear Creek (SW $\frac{1}{4}$ S22, T26N, R19W). The other is in western Major County near Ewers Creek (NW $\frac{1}{4}$ ST, T26N, R19W). In both of these caves a large percentage of the population exhibits some degree of albinism.

Ignoring those individuals whose albinism is limited to a very few scattered white or whitish hairs, the most frequent variant consists of a type designated for convenience as "chin-whiskers." In these individuals the underside of the chin and throat is white. The shape of the white area is variable, but is usually in the form of two streaks diverging posteriorly from near the tip of the chin. The effect is vaguely reminiscent of the beard of the late Emperor Franz-Josef of Austria (plate 1). Deviations from this pattern include asymmetry of the streaks, absence of either one of them, or the presence of a median streak between the other two. Forty-nine of the 79 specimens from the Woodward County cave examined were found to possess this trait, while it was found in 9 of 18 from the Major County colony.

Of much less frequent occurrence at either site are bats with large irregular areas of white hair, or with the color of the hair over the entire body dilute (plate 1). Five of these have been taken from Woodward County cave, one from the cave in Major County. A second individual with extremely bold markings was seen in a crevice at the latter site, but eluded capture. The white areas are quite irregular in shape and size, but are nearly always situated on the top of the head or across the shoulders. One specimen has two large abdominal white patches in addition to one on the shoulders. This individual is also the only one having general dilution of color in the pigmented body hair, and is further distinguished by having the unpigmented areas snow-white, as contrasted with a dirty brownish-white in the others.

Only one of the six conspicuously marked specimens were collected at random. One from Woodward County was discovered in a group of 34 brought down by a pistol-shot. The one from Major County was secured

* Contribution No. 193, Dept. of Zoology.

with 11 others from a crevice, and its unusual color was not noted until later. However, the most casual inspection of either colony reveals that, as indices of a true ratio between white-patched and normal-colored individuals, these figures have little value. The actual ratio must be nearer several thousand to one. The remaining specimens were singled out because of their conspicuous appearance and pursued until caught, hence their number signifies nothing except that this extraordinary color variation does occur with some regularity.

The chin-whiskered specimens reported here were collected in a random manner, being swept from the cave roof or caught in midair with a dipnet. No selections of any particular color type was made, and the high incidence of chin-whiskers was not particularly noted until the specimens were examined in the laboratory. Hence it is believed that the figures given above represent a typical sample of the population for chin-whisker coloration. A brief inspection of the colony in the cave is sufficient to verify the high incidence of the whiskers, for when a cluster of several hundred bats is illuminated with a flashlight they all turn towards it in a state of great excitement before taking wing, and the whiskers are then most conspicuous.

It was at first thought that the frequency of albinism in this general area of Oklahoma might be due to inbreeding, and thus indicate a stable population, with little mixing from other areas. This now seems somewhat dubious, for the writer recently observed on display at Carlsbad Caverns, New Mexico, a specimen with a large white patch on the shoulders, and one with overall dilute coloration. A card beside this display stated that these color variations

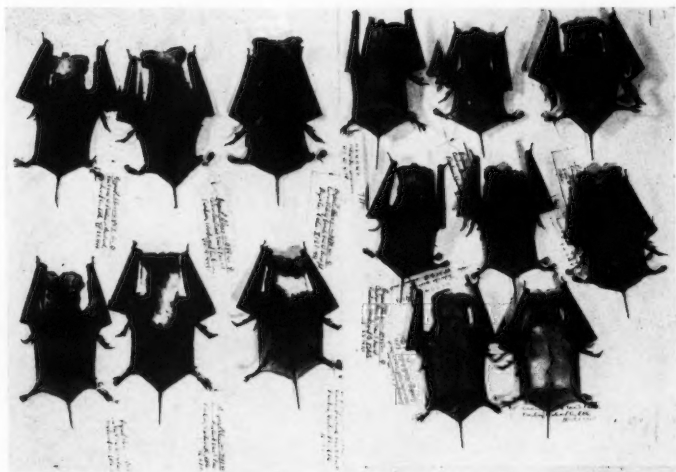


PLATE 1.—(Left) Dorsal view of six specimens of *Tadarida mexicana* from western Oklahoma, showing the more uncommon dorsal white areas. Specimen at lower right has colored body hair with pigment dilute. (Right) Ventral view of eight specimens, showing variation in the more common "chin-whisker" type of albinism. Specimen with abdominal white patches is the same specimen as shown at left, with dilute pigment. (Photography by T. O. Duncan.)

are sometimes found in the Carlsbad bat colony. The presence of chin-whiskers in this colony was not mentioned.

From the above data it seems that albinism of various sorts is common at least in certain populations of the Mexican free-tailed bat. Reexamination of colonies from all parts of the range should disclose whether these aberrations are as common elsewhere as they are in Oklahoma, and may possibly provide a clue to the better understanding of seasonal movements of the species.

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An Ecological Study of the Waterfowl of the Pot-Holes Area, Grant County, Washington

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The Columbia Basin Irrigation Project will have many effects on the present scene that one encounters in eastern Washington. Not only will the entire economy of a large section of the state be vastly altered, but the superficial appearance of the very land itself will undergo many changes. One of these changes will be the flooding of a large area of desert sand dunes lying south and west of Moses Lake, Grant County, Washington.

At a point approximately ten miles south of the city of Moses Lake and blocking the channel of Lower Crab Creek, the United States Bureau of Reclamation has constructed O'Sullivan Dam. This dam is an earthen-filled structure three and one-half miles in length and 100 feet high in some places. Waste water from the irrigation of farm lands to the north and west of Moses Lake will be impounded behind O'Sullivan Dam. Besides this waste water, additional water will be pumped into the area from Roosevelt Lake at Grand Coulee Dam. The lake thus impounded will be a storage reservoir of such size that it will join with Moses Lake. When full this reservoir will raise the present level of Moses Lake as much as six feet.

The lake will be filled to capacity during the spring run-off season and irrigation during the summer will result in the lowest water levels in the fall. The expected annual *drawdown* from this type of control will range as much as 30 feet (Bureau of Reclamation Officials, personal communication).

The sand-dune area to be flooded by the waters behind O'Sullivan Dam at present, contains hundreds of small potholes which have relatively stable water levels. These potholes provided habitat for many species of waterfowl (fig. 1).

This study was initiated June 1, 1950. The purpose of the investigation was to establish a mass of basic information about the area which could be used for future management purposes.

*ACKNOWLEDGMENTS

The author is indebted to Dr. C. F. Yocom for the many ways that he helped with the study. H. A. Hansen, D. D. Earp, and C. F. Banko of the State of Washington Dept. of Game have given the author much useful data and help. A. C. Martin of the U.S. Fish and Wildlife Service, Patuxent Research Refuge, Laurel, Maryland, identified questionable seed samples.

Personnel of the U. S. Bureau of Reclamation and of several sportsmen's groups in the Columbia Basin have the thanks of the author for the valuable assistance that they extended to him.

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PHYSIOGRAPHIC AND VEGETATIVE FEATURES

Lower Crab Creek, an intermittent stream, leaves the southwest side of Moses Lake and runs south through the sand area. The shifting sand dunes resulted from deposits left by glacial waters (Bretz, 1928). These dunes range

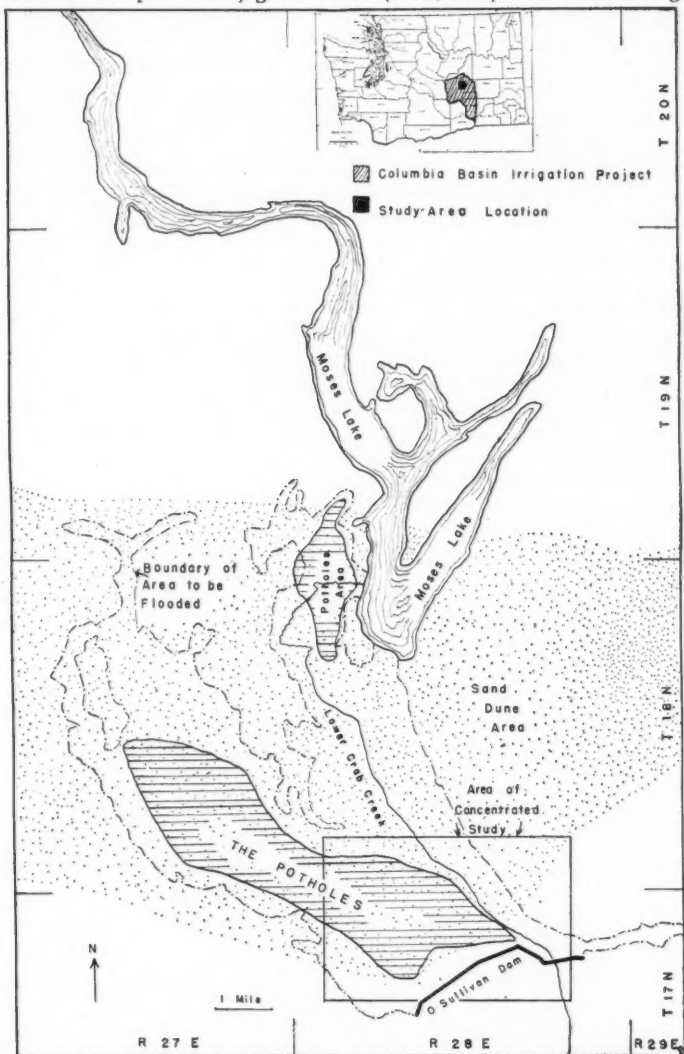


Fig. 1.—Map of potholes area

up to sixty feet in height and are moving in an easterly direction. Paralleling the course of Lower Crab Creek is a belt where the depressions between the sand dunes dip below the underground water table and create 800-1000 potholes. While some of these potholes are temporary in nature, many of them are permanent and several which support springs are drained by streams the year around. The south end of this area flattens out and over 400 potholes, sloughs, and lakes are concentrated in an area of five square miles (fig. 2).

The vegetation of southeastern Washington has been studied by Daubemire (1942) who has included most of the Columbia Plateau and all of the Grand Coulee region in the *Artemisia-Agropyron* Zone. The original vegetation of this zone was dominated by *Artemisia tridentata* and *Agropyron spicatum*. Probably nowhere else in Washington is the vegetation like that of the Potholes area. Many of the shifting sand dunes that are in the higher dry regions are largely barren of vegetation. Dunes that are at lower elevations and therefore are nearer to the underground water table, support a scattered growth of *Psoralea lanceolata* on the windward faces, a fringe of willows (*Salix*) on the crest, and sand dock (*Rumex venosus*) on the leeward faces of some.

Scattered at irregular intervals throughout the entire area are smaller sand dunes which are more or less covered with vegetation. These may be considered as *semi-stable*. These dunes exhibit a wide degree of variation in the amount and composition of vegetation; the most typical situation is a complex of rabbit-brush (*Chrysothamnus viscidiflorus* and *C. nauseosus*), sage (*Artemisia tridentata*), Grayia (*Grayia spinosa*), cheatgrass (*Bromus tectorum*), Indian rice cutgrass (*Oryzopsis hymenoides*), alkali cord grass (*Spartina gracilis*), and several other species of lesser importance (fig. 3).

The vegetation of the more moist areas shows patterns of zones arranged along a moisture gradient. The driest of these zones, which is immediately below the semi-stable-sand-dune level, is a saltgrass (*Distichlis stricta*).

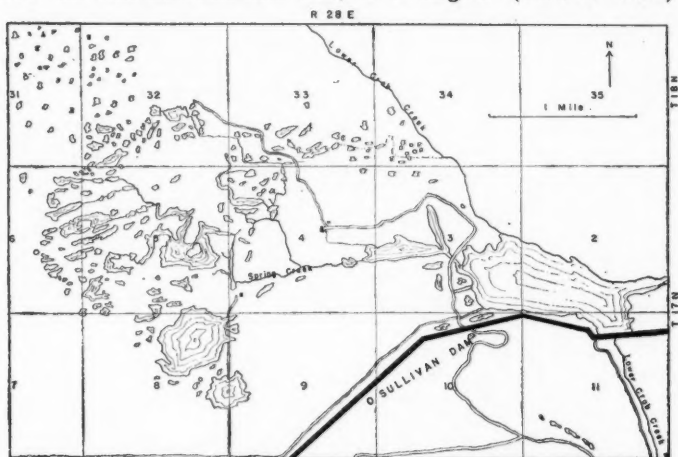


Fig. 2.—Detailed map of area of concentrated study

Nevada club rush (*Scirpus nevadensis*) community which grows on flats often extensive in size.

These saltgrass flats intergrade with a zone where the dominant plants are baltic rush (*Juncus balticus*) and sedge (*Carex douglasii*). American three-square bulrush (*Scirpus americanus*) occupies a codominant role in some areas. Plants found in association with the above in this zone are creeping spike rush (*Eleocharis macrostachya*), sedge (*Carex lanuginosa*), and Torrey's rush (*Juncus torreyi*).

A zone of bulrush (*Scirpus acutus*) grows in water to a depth of three feet. Broad-leaved cattail (*Typha latifolia*) is found also in this zone in the deeper waters of the more stable potholes. This zone occasionally occupies moist soil sites.

Water deeper than three feet supports heavy growths of submerged aquatic plants, the most common species of which are sago pondweed (*Potamogeton pectinatus*), coontail (*Ceratophyllum demersum*), and water milfoil (*Myriophyllum exalbescens*). Other plants occasionally found in this zone are bladderwort (*Utricularia vulgaris*), musk grass (*Chara vulgaris*), white-water crow-foot (*Ranunculus aquatilis*), widgeon grass (*Ruppia maritima*), and smartweed (*Polygonum natans*). Lesser duckweed (*Lemna minor*) grows profusely throughout all vegetation zones on the surface of the water.

One may commonly find semi-permanent potholes which are not deep enough to support either the open-water zone with its submerged aquatic plants or the bulrush-cattail zone. These potholes are completely grown over with the baltic rush-sedge zone and support standing water throughout the year during wet seasons, but some dry in mid-summer of drought years to moist soil (fig. 4).

There are extensive areas of marshlands where the predominant plant is a stunted form of creeping spike rush. Several streams, beginning in spring-fed potholes, support heavy growths of watercress (*Nasturtium officinale*) and monkey face (*Mimulus guttatus*). Most of these streams are dammed at frequent intervals by beaver. Such beaver dams create potholes along the streams which would not otherwise be present (fig. 5).

Prior to the construction of O'Sullivan Dam, the Potholes area was used economically for grazing cattle.

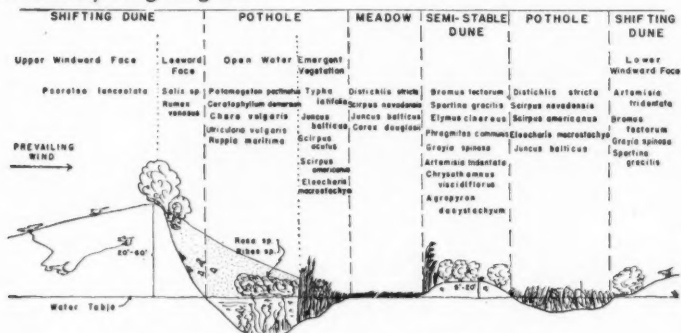
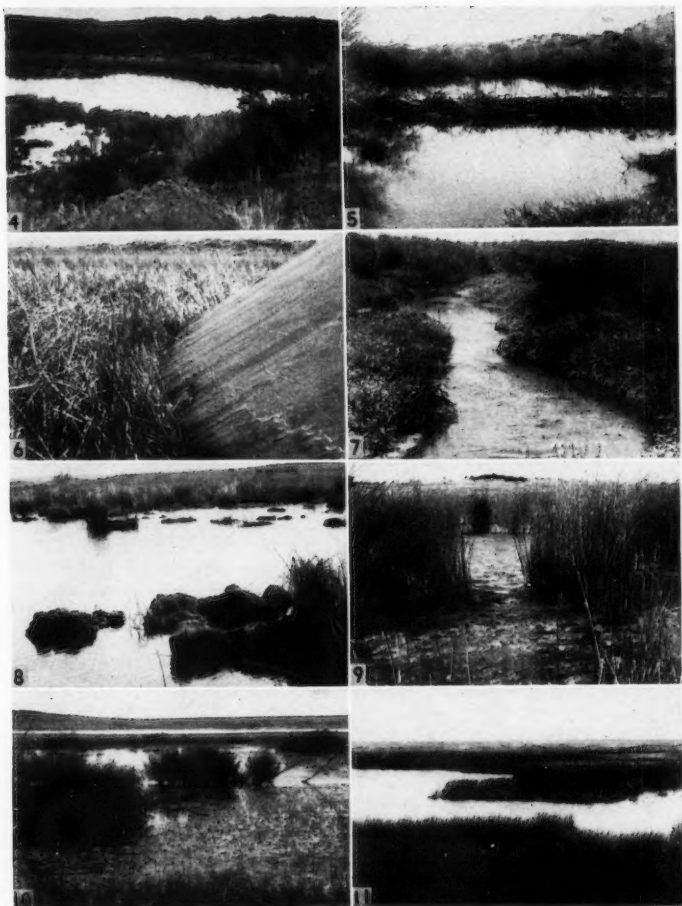


Fig. 3.—Diagrammatic profile of typical pothole vegetation

CLIMATIC DATA AND WATER CONDITIONS

The Potholes area lies in a region which receives about seven inches precipitation annually, 65-70% of which occurs during the period from October through March. The diurnal temperature ranges are great; temperatures of



Figs. 4-11.—4. Small pothole surrounded by semi-stable sand dunes. Photo by C. F. Yocom; 5. Beaver dam constructed of willow, rose, and bulrushes; 6. Sand dune encroaching on bulrush-cattail zone of a pothole; 7. Creek used by teal and mallards for territories. Photo by C. F. Yocom; 8. *Scirpus* tussocks used by territorial adults and by broods for loafing; 9. Typical *Scirpus acutus* brood cover; 10. Sprouted willow stumps used by broods for cover and shade; 11. Permanent pothole used by moulting ducks and by migrating birds in fall. Photo by C. F. Yocom.

over 100°F during mid-day of summer months with night temperatures of 50-60° are common. The winters of the area are ordinarily mild and the snowfall is about 18 inches annually. The prevailing westerly winds of the Potholes constantly move the loose sand dunes to the east, thus causing many potholes to be filled slowly with sand (fig. 6). It was estimated that these sand dunes move at the rate of one to three inches per year.

Pothole counts were made in the 15 square mile study area in early June and late August during both years of the study. The size of these potholes was estimated in acres. The counts which were 90-95% complete showed that the potholes ranged from less than one-half to more than 80 acres in size. Over 90% of the potholes were less than one acre in size. In June 1950 there were 904 potholes and 529 in August. In 1951, which was a drier year, there were 890 in June and 463 in August. In 1951, some potholes that had previously been considered permanent dried completely.

The annual vertical water-level fluctuation was measured in one of the typical potholes. The data collected show an annual fluctuation of ten inches. Most of the potholes which were not drained by streams exhibited similar fluctuations although in 1951 the levels of some potholes dropped more than ten inches. Except in the cases where potholes went completely dry, the vegetation was not noticeably affected by the fluctuation.

WINTER CONDITIONS 1950-1951

For the purposes of this study, winter conditions were considered to prevail during the period extending from the first freeze-up in fall until the first permanent thaw in spring. In Mid-November 1950, a cold wave froze waterbodies and forced most of the waterfowl out of the area. The potholes did not remain frozen long, for a survey conducted on November 24 revealed that they were all ice-free and that 200+ mallards and 5 green-winged teal were present. The weather remained mild throughout early December and during a survey of the region on December 19 and 20, more than 1300 wintering waterfowl were recorded. Of these, 1200+ were mallards. Other species recorded were gadwall, pintail, baldpate, green-winged teal, canvas-back, lesser scaup, buffle-head, American golden-eye, and Canada goose. Shortly after this December survey was made, the area once again froze over and, except for a few mallards which remained on the running streams (local citizens, personal communication), ducks were absent until late January 1951 when warm weather caused a partial thaw which reopened some of the spring-fed potholes. These potholes were never again frozen, although many of the small ones remained closed until late February.

An evaluation of the potholes as waterfowl winter range.—It is difficult to set apart a portion of the year-long waterfowl populations of the Potholes into a heading that might be termed *winter populations*. The Potholes, as well as all of the southeastern one-half of Washington, lies in the zone which separates the waterfowl wintering range and the waterfowl breeding range of the North American Continent. Consequently, waterfowl are present throughout the entire year. When a storm front descends from the north, freezing waterbodies and covering food supplies with snow, the waterfowl are forced to retreat to the south. When rising temperatures cause a thaw, thus forcing the freeze line to the north, the waterfowl are quick to follow, reoccupying opened

range as far as limiting factors will allow. Thus in winter this zone is a fluctuating edge of the northern limits of waterfowl winter range.

For the most part, there are four factors which limit the extent to which waterfowl will winter in a given region: (1) *The self-contained nature of the bird.*—Some species of waterfowl migrate to the south well before freezing weather while others remain until they are forced out by freezing weather. The primary species that remained in the Potholes during the winter was the mallard. (2) *Open water.*—With the advent of freezing weather, most of the potholes froze, thus becoming unavailable to waterfowl. Several large potholes, which supported springs and were drained by relatively large streams of running water, remained open throughout all but the coldest weather. (3) *An abundant available food supply.*—The Potholes had an abundant supply of natural foods consisting of the seeds of many species of aquatic plants. Along streams and springs, watercress, duckweed, and other plants grew in abundance and furnished green food the year around. The wheat fields of the Columbia Basin offer unlimited waste wheat within easy flying distance of the Potholes. Wheat was one of the most important foods for mallards during the fall and winter in all of eastern Washington (Yocom, 1951). Canada geese frequented the grain fields in search of the fresh green shoots of winter wheat and cheatgrass. During periods of heavy snowfall, the grains became unavailable, but the natural foods of the Potholes remained available as long as there was open water. (4) *Shelter.*—The importance of shelter is difficult to ascertain. The *Scirpus* beds of the area furnished abundant and adequate shelter from winter storms. In addition, the sand dunes, many with shrubby coverings, sheltered some potholes regardless of the direction and severity of the wind.

In an application of the above limiting factors to the Potholes, it can be seen that, during an average winter, all of the necessities of life required by waterfowl were present and available. The region provided, then, adequate wintering range for those species of waterfowl which are adapted to its winter climate.

SPRING MIGRATION

Because of the mild climate which allowed the presence of waterfowl throughout the winter, no abrupt line could be drawn between the winter populations and the spring-migration populations. A gradation occurred from winter into spring with birds constantly present, thus it was difficult for one to determine exactly when winter stopped and spring began. For this reason, the date of the first permanent thaw has been chosen arbitrarily as the line between winter and spring populations.

Species of waterfowl which migrated early in the season banded together in large numbers on the fringe of the freeze line awaiting the first permanent thaw. Immediately after this thaw, there appeared to be a noticeable northward movement of the concentrated birds. This heavy initial flight was followed by a more or less regular spring migratory flight. In mid-January, 1951, the late Derek D. Earp of the State of Washington Department of Game conducted a partial survey of waterfowl on Moses Lake during a temporary period of open water. The results of this survey are presented below: On January 10, 1951 Earp counted 5,000 mallards, one green-winged teal, and one American golden-eye. On January 11 he counted 22,500 mallards, and 1,050 Canada geese. These data indicate the concentration of mallards and

Canada geese on Moses Lake in mid-January. Shortly after the survey was made, the area once again froze over and the waterfowl were forced out, probably to the open water of the nearby Columbia River.

The first permanent spring thaw in 1951 was in late January. Eight spring migration surveys were made on key census transects on the study area. The first of these surveys was on February 18 after the heavy initial flight was largely over. The remaining seven surveys were conducted as follows: One in March, two in April, three in May, and the last on June 3.

Eighteen species of ducks and geese migrated through the Potholes during the spring of 1951. The peak period of migration for each species is listed below:

SPECIES	PEAK
Mallard	Early February
Gadwall	Early March and Early May
Pintail	Mid-March
Baldpate	Early April
Green-winged Teal	Late April
Blue-winged Teal	Mid-May
Cinnamon Teal	Mid-May
Shoveller	Mid-April
Redhead	?
Canvas-back	?
Lesser Scaup	Mid-April
Buffle-head	Mid-March
American Golden-eye	Early March
Barrow's Golden-eye	Early March
Ruddy Duck	Late April
American Merganser	?
Canada Goose	Early February
White-fronted Goose	?

The relative abundance of the commonest species of waterfowl that migrated through the Potholes during the spring of 1951 is shown below:

PUDDLE DUCKS	DIVING DUCKS	ALL WATERFOWL
1. Mallard	1. Ruddy Duck	1. Mallard
2. Green-winged Teal	2. Redhead	2. Canada Geese
3. Baldpate	3. Lesser Scaup	3. Green-winged Teal
4. Gadwall	4. Buffle-head	4. Ruddy Duck
5. Pintail	5. Canvas-back	5. Baldpate
6. Shoveller	6. American Golden-eye	6. American Coot

During the spring migratory period, water conditions in the Potholes area were at their best. The evaporation rate was low and the spring run-off from winter snow had filled every depression with water. Loafing areas were abundant. The flooding of large saltgrass flats with one to six inches of water made a vast quantity of food available in the form of saltgrass seeds and Nevada club-rush achenes, etc. These flooded areas were heavily utilized by migrating waterfowl including divers such as the redhead and lesser scaup which, under these conditions, fed in the manner of puddle ducks by *tippling up*.

During spring migration the flock size of most species of ducks which were unpaired averaged from ten to twenty birds. Paired birds were usually seen in groups of two to four pairs. Only two species were noted to migrate in large flocks. On the morning of April 22, 1951 a single flock of 977 ruddy ducks was observed on the main lake behind O'Sullivan Dam. These birds apparently arrived during the night for there were only 79 ruddies present on

the lake at dusk the previous evening. Two flocks of Canada geese, one of 132 and the other of 164 birds, were recorded on February 18, 1951.

The data collected indicate that most species departed at dusk and arrived sometime in the night or early morning, resting and feeding during the day.

SEX RATIOS AND COURTSHIP

Most of the data on sex ratios were collected concurrently with the spring migratory data. Although the data are limited, five patterns of migration with respect to sex ratios were recognized (table 1).

TABLE 1.—Sex Ratio Data for the Potholes—1951

		Feb. 18	Mar. 17	Apr. 3	Apr. 22
		♂ ♀ ♂ ♀	♂ ♀ ♂ ♀	♂ ♀ ♂ ♀	♂ ♂ ♂ ♀
Mallard	Pair	361	199	234	36
	Total	446 421	236 217	266 243	53 39
	Ratio	106:100	109:100	110:100	140:100
Pintail	Pair	26	66	31	
	Total	38 34	106 98	63 48	
	Ratio	112:100	108:100	131:100	
Gadwall	Pair	13	30	65	33
	Total	83 37	53 42	94 76	41 35
	Ratio	250:100	126:100	124:100	117:100
Baldpate	Pair	12	40	172	
	Total	22 15	46 43	198 181	
	Ratio	147:100	107:100	109:100	
Green-winged Teal	Pair	7	71	258	107
	Total	10 11	86 75	279 267	108 107
	Ratio	91:100	115:100	104:100	101:100
Blue-winged Teal	Pair				
	Total				
	Ratio				
Cinnamon Teal	Pair				5
	Total				6 5
	Ratio				120:100
Shoveller	Pair			15	55
	Total			27 19	134 77
	Ratio			142:100	174:100
Redhead	Pair	5	4	16	16
	Total	10 7	9 6	36 24	20 18
	Ratio	143:100	150:100	150:100	111:100
Lesser Scaup	Pair	1	8	2	13
	Total	17 7	49 20	59 24	58 22
	Ratio	242:100	245:100	246:100	264:100
Buffle-head	Pair	3	9	9	14
	Total	13 18	35 30	32 15	16 15
	Ratio	72:100	117:100	214:100	107:100
Ruddy Duck	Pair	0		0	1
	Total	1 3		2 1	956 111
	Ratio	34:100		200:100	861:100

TABLE 1.—(continued)

		May 5		May 12		May 26		June 3	
		♂	♀	♂	♀	♂	♀	♂	♀
		♂	♀	♂	♀	♂	♀	♂	♀
Mallard	Pair	63		63		33		22	
	Total	119	72	181	69	175	50	170	50
	Ratio	165:100		262:100		350:100		340:100	
Pintail	Pair Total Ratio								
Gadwall	Pair	33		33		4		9	
	Total	49	38	35	33	17	9	42	15
	Ratio	129:100		106:100		189:100		280:100	
Baldpate	Pair	16							
	Total	41	22						
	Ratio	191:100							
Green-winged Teal	Pair	51		9					
	Total	58	52	10: 9					
	Ratio	112:100		111:100					
Blue-winged Teal	Pair	7		11		13		12	
	Total	7	7	11	11	30	13	24	12
	Ratio	100:100		100:100		231:100		200:100	
Cinnamon Teal	Pair	27		21		16		11	
	Total	31	28	27	21	38	17	31	15
	Ratio	111:100		133:100		222:100		207:100	
Shoveller	Pair	26		7					
	Total	41	32	13	7				
	Ratio	128:100		181:100					
Redhead	Pair	44		28		8		27	
	Total	69	53	42	30	54	19	38	28
	Ratio	130:100		140:100		284:100		136:100	
Lesser Scaup	Pair	13		0					
	Total	31	13	9	2				
	Ratio	238:100		450:100					
Buffle-head	Pair Total Ratio								
Ruddy Duck	Pair	1		1		2		3	
	Total	50	9	4	1	6	2	6	3
	Ratio	555:100		400:100		300:100		200:100	

1. Ratio even or nearly so throughout the spring migratory period. The mallard and green-winged teal exhibited this pattern. Yocom (1949) found a sex ratio of 109:100 in mallards, based on direct observations of 8,805 birds. A similar overall ratio was found in the present study. After mid-April, a steady increase was noted in the number of male mallards over females. This was caused by nesting females remaining unobserved and the flocking of post-breeding males which had deserted their mates.

2. Ratio heavy to males early in the season, but soon leveled off and the greater portion of the migration, including the peak was even or nearly so. This pattern was exhibited by the gadwall and the baldpate. Most of the baldpate females observed were paired by the time they reached the Potholes, while the majority of the gadwall females that arrived early in the season were unpaired birds. As in the case of the mallard, a steady increase of males, caused by the flocking of postbreeding males, was noted after early May.

3. Nearly even ratio early in the season followed by a sharp increase of males late or during the peak. The pintail, blue-winged teal, and the cinnamon teal followed this pattern. In the case of the pintail, the late season increase in males was not as marked as in the two teals.

4. A heavy preponderance of males throughout the spring migratory period as in the shoveller, redhead, lesser scaup, and ruddy duck. Gehrman (1951) noted a preponderance of male lesser scaup early in the season, suggesting a differential sex migration at West Medical Lake, Spokane County, Washington. There was no evidence in the present study that suggested such a differential sex migration.

5. Early and late season populations with nearly equal ratios, and the males having a later peak in migration than the females. This pattern was exhibited by the buffle-head.

Courtship activities were noted as early as mid-December in the mallard. The latest courtship behaviors were those of the blue-winged teal, cinnamon teal, and ruddy duck, all recorded in June. Considering all species, courtship activities reached a peak in late April and early May.

The usual size of courting party was two to four males attending one female. The largest single courting party was recorded on April 22, 1951 when 21 shoveller males were observed in pursuit of one female. From the number of paired birds that are indicated in table 1, it is obvious that many birds had completed their courtship and had mated by the time they reached the Potholes.

THE NESTING SEASON

TERRITORIALISM

The term *territory* as applied herein designates a defended area which was occupied by a pair of waterfowl during the prenesting period and part of the nesting period. Most of the observations of territorialism were recorded during the spring and early summer of 1951.

Physical characteristics of territorial sites.—Permanent potholes supporting growths of cattails and bulrushes furnished territorial sites for ruddy ducks, redheads, coots, pied-billed grebes, and many of the puddle ducks. The several miles of creeks were used extensively by mallards, blue-winged teal, and cinnamon teal (fig. 7). Many small temporary potholes present only in spring and early summer were heavily utilized by the three species of teals, mallards, gadwalls, and shovellers.

Four characteristics which have been set forth by Hochbaum (1944) as requirements for waterfowl territorial sites are: 1) a water area, 2) a loafing or resting site, 3) nearby nesting cover, and 4) food. The characteristics of

territories observed in the Potholes did not in all cases include food. Rather, they were as follows:

1. A water area, used by the ducks for preening, mating, and sometimes feeding.
2. Loafing sites used for resting and preening. In most cases, the loafing sites were located on tussocks of grass or other elevated areas along the shoreline. Tussocks of bulrush (fig. 8) and muskrat houses were also used.
3. Nearby nesting cover. Except for the earliest nests, there was suitable nesting cover to the water's edge in all potholes that were used as territories. Mallards and pintails that nested early were obliged to use clumps of vegetation on semi-stable sand dunes. These clumps were always within walking distance from the territory.

Birds seldom left the territorial *waterbody* for any purpose other than to drive away intruders or to go to the nest. Not all feeding was done on the territory. Ducks which had established territories in a given section of the pothole often swam to neutral open-water areas or undefended shoreline areas of the same pothole to feed. When feeding in such areas, the males kept close watch on their own territories even though they were often some distance away. Whenever an individual of the same species swam or flew near the unoccupied territory, the resident male, usually followed by the female, left the feeding area and flew to the defense of his territory. This behavior was most often noted in coots, mallards, blue-winged teal and cinnamon teal. In the feeding area, territorial pairs became mixed with other birds of the same species representing all stages of the breeding cycle without friction.

Potholes of less than one-half acre sometimes maintained four or five territorial pairs, usually all of different species. The earliest territorial behavior was noted on March 17, 1951 when two pairs of Canada geese were observed defending knolls overlooking large potholes about 20 acres in size.

After April 1 territorialism was common. Mallards, pied-billed grebes, and coots were among the first to defend territories, and as each species came into the breeding cycle, more and more territories were established and defended. The latest territorial behaviors were those of blue-winged teal and ruddy ducks in mid-July. The later territorial pairs of all species seemed to be less vigorous in their defense than those of the early and peak seasons.

Defense of the territory.—There seemed to be a marked difference in the intensity of the defense between individuals of the same species. Mallards, gadwalls, shovellers, coots, and pied-billed grebes were the most ardent defending species. Blue-winged teal, cinnamon teal, and green-winged teal were the most tolerant. In the case of ducks, territories were most often defended only against individuals of the same species, while most coots and pied-billed grebes pursued any waterbird that came within range. On one occasion, a coot was observed in pursuit of a muskrat that dived to escape. Small water areas often held a pair of two or three different species without friction. No injuries were attributable to territorial conflicts.

In all observed defenses against flying birds, only one case of what appeared to be mistaken identity was observed. A male gadwall was defending an area of water from any gadwall that came within sight. Time after time, this drake left the pothole to challenge other gadwalls sometimes flying at such a dis-

tance that it was impossible for the observer to identify them without the aid of binoculars. This male had just returned from one of these flights, when a female baldpate suddenly appeared from behind an adjoining sand dune and flew near the pothole. As soon as the baldpate first appeared, the gadwall took off and started toward her, but he had no more than gained flying speed when he apparently discovered his mistake, whence he turned and dropped back to the pothole before approaching within 100 feet of the baldpate. There were no other ducks in sight at the time.

NESTING

Eleven nests located in 1950 included four mallard, one gadwall, two green-winged teal, two blue-winged and/or cinnamon teal, one redhead, and one unidentified teal. Of 57 nests found in 1951, there were 18 mallard, four pintail, three gadwall, two green-winged teal, one blue-winged teal, four cinnamon teal, seven blue-winged and/or cinnamon teal, three shoveller, one redhead, three ruddy duck, five unidentified teal, and six unidentified duck.

Summary of data pertaining to nests.—The data on nesting have been divided into five major groupings.

1. History complete. Thirty nests were first located during either the building period, the egg-laying period, or the incubation period and watched until the ultimate status was determined—hatched, deserted, or destroyed.

2. Vacated when found. In 30 nests, the ultimate outcome had been completed before they were located. Girard (1939) points out methods by which one can determine if a nest has hatched or has been destroyed.

3. Investigation site only. This group includes only five well-defined bowls scooped out of patches of vegetation apparently by hens investigating nesting possibilities there, but in which no eggs later appeared. Down was usually present in small amounts in such instances. Bennett (1938) recorded similar sites for the blue-winged teal in Iowa.

4. False starts. Two nests were found in which there was a slight bowl with one or two well covered eggs, but to which females never returned.

5. Ultimate status unknown. This includes one nest which was never rechecked to determine the outcome of incubation.

Nests that were located after they were vacated were identified by the down and breast feathers lining them by the use of keys developed by Broley (1950).

Time of nesting.—The nesting season in the Potholes extended from early April until the last part of August. The earliest waterfowl nesting attempts were those of mallards. Canada geese undoubtedly nested earlier, starting in late March, but no nests were located in the Potholes to verify this. There were a few nests of redheads and ruddies which hatched as late as the last part of August.

Selection of the nest site.—Several indirect observations on nest selection were obtained. These consisted of following the tracks of a duck from a pothole where a territorial pair was known to exist onto the sand dunes. One such trail of a mallard led for 82 yards back from the pothole and almost every clump of *Chrysothamnus* and *Grayia* in a strip approximately ten feet wide for the entire distance had been inspected. Several clumps had been

matter down and breast feathers were found in some of these as if the hen had crawled inside the clump and *tried it on for size*. Most of the observations represented mallards and nests later developed in two instances. Only rarely were two sets of tracks observed which suggested that the male might have accompanied the female. The tracks always led from the pothole back onto a dune for some distance and then the trail ended where the duck had apparently flown back to the pothole.

Nesting cover.—Early in the nesting season, the meadows were undeveloped and unsuitable for use by nesting waterfowl. At that time of the year, the vegetation of the semi-stable sand dunes was used heavily by nesting waterfowl. The shrubby plants that were used for cover on these dunes were *Grayia spinosa*, *Chrysothamnus viscidiflorus*, *C. nauseosus*, and *Artemisia tridentata*. In addition, wild rye grass (*Elymus cinereus*) was used by the early-nesting females. This plant grew in small patches at the bases of semi-stable dunes, and in small swales between dunes. In April and early May before the meadows were grown up, the old stems from the previous year augmented by 12-18 inches of new growth afforded fair protection. Of the 68 nests found during the two-year study, 27 (40%) were discovered in wild grass and the shrubs on the semi-stable sand dunes. Of these, 14 were mallard, two were pintail, one was blue-winged or cinnamon teal, two were cinnamon teal, one was green-winged teal, one was redhead, two were unidentified teal, and four were unidentified duck.

Beginning in early May, the vegetation of the meadows became available to nesting waterfowl and there was a noticeable shift at once to meadow vegetation. Few nests were found in the scattered, relatively poor nesting cover on the semi-stable sand dunes after mid-May. *Juncus balticus*, accompanied by one or more of the following species, formed the cover for the meadow nests: *Carex douglasii*, *Rosa woodsii*, *Distichlis stricta*, *Bromus tectorum*, *Poa pratensis*, and *Scirpus nevadensis*. Of 32 (47%) nests found in meadows, three were mallard, two were pintail, three were gadwall, three were shoveller, three were green-winged teal, eight were blue-winged and/or cinnamon teal, one was blue-winged teal, two were cinnamon teal, one was ruddy duck, four were unidentified teal, and two were unidentified duck. The high frequency of teal nests in this cover was probably due to the fact that teal are late nesters, and that *Juncus* meadows were relatively unavailable early in the season.

In addition to the above, three mallard nests (4%) were found in *Salsola kali*. The previous years' plants that had been bunched in large piles by the wind were used early in the season. Two (3%) mallard nests were found in the previous years' stems of *Amaranthus*, an uncommon early nesting cover. *Scirpus acutus* was undoubtedly a more important nesting cover than the data indicated. In the case of this cover, searches for nests were not made in proportion to its abundance and as a consequence, only four nests (6%) were located in bulrushes. Of these there were two ruddy duck, one redhead, and one gadwall.

Some ruddies constructed ramps of *Scirpus acutus* stems which led to the nest. They used these as a means of reaching and leaving the nest. Ramps were also built by coots.

Forty-three (63%) nests were within 30 feet of the nearest water. The distance from water varied from zero to 342 feet.

Nesting success.—Of the total of 57 nests located in 1951, 11 (20%) successfully hatched. It was easier to find a nest that had been destroyed than one that had successfully hatched. For this reason, the above 20% is not a true percentage of nesting success since it includes not only nests upon which the histories are complete, but also those which had been vacated when first found (in the latter group, undoubtedly a greater percentage of destroyed nests were found than ones which had hatched). If one considers only those nests upon which the histories are complete, the 1951 total becomes 26 of which 9 or 35% successfully hatched. This figure more nearly approaches the correct percentage, but it is also subject to error. The observer's trail, for example, makes nests more vulnerable to predators, thus a higher nest mortality may have resulted than would have occurred had they not been under observation. In 1951, a total of 322 eggs were observed. Of these, 195 (60%) were destroyed by predators, 83 (26%) successfully hatched, 40 (12%) were deserted, 3 (1%) had dead full term embryos, and one (trace) was infertile. These figures include all nests found in 1951. Factors of nest destruction will be discussed under the section on *influences of other species*.

Period of hatch.—Table 2 shows the hatching periods of broods observed in the Potholes by weeks. These figures were computed from estimated ages of broods taken in the field by the use of a method employed by Jeffrey (1947).

It is evident that the 1950 season was, on the average, two weeks later than the 1951 season. The peak of hatching for the mallard occurred the third week in June in 1950 and the last week in May or the first week in June in

TABLE 2.—Periods of hatch—determined from brood ages
(Number of broods hatched in each week indicated)

Species	Year	No. of Broods	May					June			
Mallard	1950	43		1		1	7	9	5	10	4
	1951	58	3	3	6	8	11	11	7	2	2
Pintail	1950	14					2	2	3	2	1
	1951	5	1		1				2		1
Gadwall	1950	20					1	1	2		3
	1951	29				1		1	9	4	5
Baldpate	1950	4							3		1
	1951	3									2
Green-winged Teal	1950	16					1	1	3	5	2
	1951	14				1		4	4	2	1
Blue-winged and/or Cinnamon Teal	1950	40							3	7	8
	1951	34				1	1	1	5	7	6
Shoveller	1950	17				1	1	5	3	2	
	1951	13			1		1	4	2	2	2
Redhead	1950	21					1	4	4	4	4
	1951	22		1	1	1	1	1	2	2	4
Ruddy Duck	1950	22						1		4	2
	1951	21						1		1	2
Coot	1950	156		1		13	27	23	30	31	12
	1951	180		1	1	12	34	29	54	28	15
Pied-billed	1950	12					1	3	2	1	1
	1951	17		2	6		3	1	1	1	

TABLE 2.—(continued)

Species	Year	No. of Broods	July				August	
Mallard	1950	43	3	1	1		1	
	1951	58	2	1	2			
Pintail	1950	14	2			2		
	1951	5						
Gadwall	1950	20	4	4	4	1		
	1951	29	2	2	4		1	
Baldpate	1950	4						
	1951	3			1			
Green-winged Teal	1950	16	3	1				
	1951	14	2					
Blue-winged and/or Cinnamon Teal	1950	40	10	7	3	2		
	1951	34	4	4	3	2		
Shoveller	1950	17	1	2	2			
	1951	13					1	
Redhead	1950	21	1	1	1	1		
	1951	22	2	3	2	1		1
Ruddy Duck	1950	22	4	2	3		5	1
	1951	21	2	3	5	3	2	1 1
Coot	1950	156	8	6	2		3	
	1951	180	1	3	2			
Pied-billed	1950	12	1	2	1			
	1951	17	1	1			1	

1951. The same general pattern holds true for almost all of the ducks affected. The species which nested later in the season did not seem to be noticeably affected. U. S. Weather Bureau data show that the spring of 1950 was extraordinarily dry and cold. The effects of weather on game-bird hatching periods has been discussed by Yocom (1950) and by Buss and Swanson (1950). These workers point out the correlation of the cold and wet spring of 1948 to retarded hatching peaks. Gehrman (1951) recorded the late 1950 season as compared with the 1949 season at West Medical Lake for the lesser scaup. It is unknown if the cold, dry climatic conditions in the spring months of 1950 were directly or indirectly the cause of the late hatching peaks. It was evident that the vegetative development of nesting-cover plants was retarded as much as a month in 1950. It is possible that this may have had some influence on the overall late hatch.

THE BROOD SEASON

Ten species of ducks successfully hatched young in the Potholes during both years of the study. In addition to these ducks, coots and pied-billed grebes raised young during both seasons and the great basin Canada goose (*Branta canadensis moffitti*) was known to have successfully reared broods in 1950. The coot was the overwhelming leader in the number of broods produced. In 1950, of 387 total broods observed, 157 (40.6%) were coots while in 1951, of 427 total broods, 187 (43.1%) were coots. In 1950, of the total broods there were 46 mallards, 41 blue-winged and or cinnamon teal, 22 ruddy, 21 redhead, 20 gadwall, 18 green-winged teal, 18 shoveller, 14 pintail, four baldpate, two Canada goose, 13 pied-billed grebe, and 11 unidentified duck.

In 1951, of the total broods there were 65 mallard, 36 blue-winged and/or cinnamon teal, 33 gadwall, 22 redhead, 21 ruddy, 18 green-winged teal, 15 shoveler, seven pintail, three baldpate, 17 pied-billed grebes, and six unidentified duck.

The blue-winged teal and cinnamon teal were treated as one group since it is impossible to distinguish between the females of these two species in the field. It was possible to assign a portion of the total broods counted to each species by counting territorial males during the nesting season and applying the ratios determined from such counts to the broods seen. This method assumed that both species had equal nesting success. In 1950, 67 blue-wing males and 60 cinnamon males were counted including duplicate counts; this was a ratio of 112 blue-winged teal to 100 cinnamon teal. In 1951, the counts were 66 blue-winged teal and 95 cinnamon teal, a ratio of 70:100. When these ratios are applied to the brood data, 5.6% of all broods were blue-winged teal and 5% were cinnamon teal in 1950; in 1951, 3.5% of all broods were blue-winged teal and 4.9% were cinnamon teal.

The brood season extended from late April until early September. Earliest hatched broods were mallards, coots and pied-billed grebes. The latest hatched broods were ruddy ducks. Peak of hatching has already been discussed in the section on nesting (table 2). After early September, ducks too young to fly were occasionally observed, but since they were not accompanied by an adult female, they were not considered as complete broods.

POTHOLES AND COVER USED BY BROODS

There were two common types of potholes in the study area. The typical pothole described in the section on vegetation was somewhat more common than the type which had only *Juncus balticus* cover. All of the *Juncus* pothole types were less than two acres in size and over 90% of the *Scirpus* types were less than five acres in size. Potholes of any given size were used, by broods, in approximate proportion to their abundance. No preference by broods to a particular size-class of pothole could be discovered. Some potholes were not used either year. In most instances, cover types of the used and the unused potholes were similar; carp (*Cyprinus carpio*) were present in the unused potholes. Carp were observed to destroy submergent vegetation in several potholes; it is suspected that this had some effect upon the use of such potholes by broods since feeding conditions were not favorable as the other potholes which had no carp. In Ohio, Weir and Starr (1950) noted the uneasiness and restlessness of waterfowl on a lake heavily infested with carp. The writer observed similar behavior of waterfowl on several potholes which were contaminated with carp. Such bodies of water had no submergent vegetation, broods did not use them, and adult birds avoided them for the most part.

While the broods observed in the Potholes by no means remained in one type of cover, six principal cover types have been recognized. All broods were observed to spend the majority of their time in one or more of the following six cover types (table 3) which are arranged according to their importance.

Scirpus acutus.—This single cover type, the most important in the area studied, was used extensively as feeding cover by many broods and as escape cover by fully 70% of all broods (fig 9).

Juncus balticus.—This important cover was very abundant in all potholes,

TABLE 3.—Primary cover types of broods (figures indicate percent for each species)

	<i>Scirpus acutus</i>	<i>Juncus balticus</i>	Open Water	<i>Typha latifolia</i>	<i>Scirpus americanus</i>	<i>Salix</i> spp.
Mallard	37	34	18	8	2	1
Pintail	43	57				
Gadwall	77	7	13	3		
Baldpate	43		57			
Green-winged Teal	17	50	28		5	
Blue-winged and/or Cinnamon Teal	36	30	18	6	1	9
Shoveller	60	33				7
Redhead	27	27	41		5	
Ruddy Duck	33	14	48	5		
Coot	33	52	4	8	2	1
Pied-billed Grebe	41	6	53			

and was the only cover available in many. This type was a very good feeding cover, but slightly less desirable than *Scirpus acutus* as escape cover. Broods usually swam from *Juncus* to *Scirpus*, if present, to escape from the observer.

Open water.—Although not usually considered as cover, this type is included here because it played an important part in the rearing of nearly all waterfowl broods in the Potholes. It was used extensively as a feeding area by all species. The broods seemed to feed upon the abundant insect life within five feet of the edges of the vegetation zones in open water over submerged aquatic plants. Many broods used open water as a means of escape, swimming to the center of a pothole upon the approach of the writer. They would swim back to the shoreline-vegetation zone to feed or loaf after the pond was passed. It was frequently observed that when a brood was flushed from shoreline vegetation (usually *Juncus*) the young rushed to open water where they often dived and presumably swam under water to vegetative cover. The ducklings were not usually seen again after they dived.

Typha latifolia.—Cattail was used in the same manner as *Scirpus acutus* but was not important because it was relatively uncommon.

Scirpus americanus.—Three-square bulrush was common locally in some potholes and provided excellent feeding cover.

Salix.—A few potholes had standing willows in the water. These willows were utilized extensively for escape, feeding areas, and for loafing. Broods frequently were observed loafing in the shade of willows during the hot part of the day (fig. 10).

BEHAVIOR OF MOTHER AND YOUNG

Feeding.—Young ducks apparently fed largely on invertebrate life for the first two or three weeks of their lives. For the most part, the downy young of the surface ducks were observed feeding on aquatic insects in open water near shoreline vegetation. Frequently broods were observed to feed also by tipping up over beds of submerged vegetation. The nature of the food con-

sumed in those cases was unknown, but supposedly aquatic invertebrates were taken in large numbers at such times. These alkaline potholes supported a high population of *Gammarus*, microcrustaceans, and immature forms of many insects. Considerable feeding on land in the *Juncus* meadows bordering the potholes was done by all species of puddle ducks, redheads, and coots.

The downy young of redheads and ruddies were seen most often feeding in open water over beds of *Potamogeton pectinatus*. These broods fed largely by diving. The females of these two species often dived with the broods.

Feeding was done largely in the cool periods of the day when insects were more active. The midday hours were often spent loafing on muskrat houses, *Scirpus* tussocks, under willows, or along the shoreline. Loafing places used by broods were located generally in the shade.

There was considerable movement by broods overland between potholes. It is suspected that such overland movements added considerably to brood mortality by predators.

Escape.—Broods of puddle ducks and redheads usually hid themselves in the nearest available cover as soon as the observer was visible. When the cover was searched, broods were found within a few yards of the point where they had entered the cover. The females were the first to flush. Usually they would rush from within a few feet of the observer and would feign, whereupon the young often rushed off across the water at top speed headed for other cover. Feigning behavior of the females apparently acted as a release stimulus for the broods to seek cover.

Ruddy broods when alarmed merely swam farther away from the observer. The only display of fear exhibited by the female and the young was an exact replica of the *head-and-neck courtship pump* of the male; this was observed many times. Hochbaum (1944) noted courtship behavior in downy young redheads and canvas-backs and suspected it to be a fear reaction. Courtship behavior appeared to be a fear reaction in the case of the downy ducks observed in this study, for it was observed only in instances where broods were obviously alarmed.

Duck broods were commonly chased by coots, pied-billed grebes, and other ducks. In most instances, the attending mother quickly led the brood away from the antagonists. Munro (1939) points out that mortality to young ducks from encounters with coots or grebes is "undoubtedly casual or sporadic and does not represent a serious drain on waterfowl production." In this study, no injuries of young were observed to have been inflicted from attacks by coots. The presence of coots on small potholes seemed to make them less desirable to duck broods. Sooter (1945) states, "The coots, by protecting their own brooding areas, influence the attractiveness of such places for feeding grounds for ducks." It is suspected that the high breeding population of coots served to partially limit duck populations in the Potholes. Coots and ruddy ducks frequently occurred on the same pothole without friction. The reason that these two species occurred together undoubtedly was associated with acceptable nesting cover, although Low (1941) has pointed out that the ruddy duck is more tolerant of other nesting birds than the redhead.

Abandonment of the broods.—In general, puddle duck females remained with their broods until the broods were over two-thirds grown. Fully one-half

of the ruddy and redhead broods were without attending adult birds by the time they were one-half grown.

BROOD SIZE

A general reduction in size of broods with increasing age was noted. Most of the reduction in brood size occurred during the first two or three weeks after hatching. Including the coot and all species of ducks, an average of five young per successful nest was raised to the age of two-thirds grown or older in 1950, whereas in 1951 this average was almost six.

PRODUCTION

An effort was made to determine the waterfowl production in the Potholes for the two years of the study. At least 90% of the potholes in the area were covered one or more times on foot during the peak of the hatching season. Using several key census areas as a base, it has been estimated that about 60% of the total broods in the area came under observation. The estimated waterfowl production for the Potholes during 1950 and 1951 is shown below.

	1950	1951
Observed number of broods	372	410
Estimated percentage of total	60	60
Estimated number of broods	620	680
Number of young per brood to mature	5	5.9—
Estimated production	3100	4000

These estimates are considered conservative.

THE POSTBREEDING PERIOD

The postbreeding period extended from the time that the first male was observed to desert his female and begin the summer eclipse molt until the time when fall migration started. Ducks gathered in flocks prior to the loss of their flight feathers and after they had abandoned their females and nests or broods. They were observed and counted easily at this time since they spent much of their time feeding and preening on large flooded saltgrass flats in clear view of the surrounding sand dunes from which observations were made. The molting ducks remained on the flooded flats until they became flightless, whereupon they moved to large potholes which were well stocked with *Scirpus acutus* cover, or until they left the Potholes area entirely.

Large flocks of molting pintails, baldpates, green-winged teal, and redheads were observed in the Potholes during the postbreeding period. These birds largely moved into the Potholes from other breeding areas. Many of these remained all summer and passed through the eclipse molt; other spent only five to ten days in the Potholes, feeding and preening, after which they moved on to an unknown area to molt. Such flocks usually remained intact and their numbers and behavior remained fairly constant from day to day.

Molting mallards, gadwalls, blue-winged teal, and cinnamon teal appeared to represent only the resident breeding populations. Very few shovellers were observed to molt in the Potholes. It was apparent that the resident breeding shovellers moved elsewhere to molt. Small numbers of wood ducks, lesser

scaup, and two male buffle-heads (1950) were observed in the Potholes during this period.

After the adult birds had regained their power of flight upon completion of the eclipse molt, they again collected on large flooded flats where feeding conditions were excellent. They were joined here by young of the year which could fly. This flocking usually began in early August and continued through the beginning of fall migration in late August. During this period, the various species were often mixed when feeding on the flats, but when they were flushed, they invariably segregated into separate flocks of individual species. These flocks of summering birds were joined in August by early fall migrants which had molted or were raised elsewhere. Late-molting birds not yet flightless were present also in these flocks.

FALL MIGRATION

The late summer concentration period graded into the beginning of fall migration and it was difficult to determine exactly when one period stopped and the other began. Flocks of birds which acted as though they were migratory, particularly pintails, were observed as early as late July but these observations were uncommon and inconclusive. By late August, concentrations of birds that exhibited migratory behavior were common. As has already been indicated, the date of the first complete freeze up has been arbitrarily chosen as the debarkation between fall migration and winter. Possibly this is not a valid criterion, since the first complete freeze up often occurs quite early in the season, followed by warm weather which reopens waters, and allows ducks to return. The return of ducks into an area recently freed of ice may represent fall migrants which later move on south, but it is suspected that most of such birds were wintering there.

Twenty species of waterfowl migrated through the area during the fall of 1951. The peak period of migration for each species is shown below:

SPECIES	PEAK
Mallard	October-November
Pintail	Mid-October
Gadwall	Mid-October
Baldpate	Late October
Green-winged Teal	Late September
Blue-winged and/or Cinnamon Teal	Late August
Shoveller	?
Wood Duck	Mid-September
Redhead	Mid-September
Canvas-back	?
Lesser Scaup	Late October
Buffle-head	Late October
Golden-eyes	Late October
Ruddy Duck	Mid-September
Hooded Merganser	Mid-November
Canada Goose	Early November
White-fronted Goose	Late October
American Coot	Mid-September
Whistling Swan	?

The relative abundance of the commonest species of waterfowl that migrated through the Potholes during the fall of 1951 is shown below:

PUDDLE DUCKS	DIVING DUCKS	ALL WATERFOWL
1. Mallard	1. Ruddy Duck	1. Mallard
2. Green-winged Teal	2. Hooded Merganser	2. Green-winged Teal
3. Baldpate	3. Buffle-head	3. Ruddy Duck
4. Pintail	4. Lesser Scaup	4. Canada Goose
5. Gadwall	5. Golden-eyes	5. American Coot
6. Blue-wing and Cinnamon Teal	6. Canvas-back	6. Baldpate

The flocks in fall were up to 1000 birds in size. These birds used large bodies of water and neglected the small individual potholes which is in direct contrast to the spring migration (fig. 11). The birds were much more wary in the fall than during spring, and often flushed if the observer allowed any part of his body to come into sight. When flushed, the fall birds flew off in large flocks, predominantly of the same species, and often left the area entirely, and when they remained in the area, they flew from one large pothole to another.

Much feeding was done on the area by all species except the mallard. This feeding was done along the edges of large potholes and flats. Mallards and Canada geese were observed to leave the Potholes and fly to the east and southwest where presumably they fed in grain fields. Puddle ducks were observed to leave the area at all times of the day and head directly south as they flew out of sight. Divers usually were observed to leave at dusk or during the night.

THE HUNTING SEASON

In the past, the harvest of waterfowl in the Potholes area undoubtedly was light because the owners of the cattle ranches posted their land and most of their hired riders to patrol the fences during hunting seasons to keep trespassers out. The only hunting was that done by the owners and their friends. From all available information, this hunting was not heavy. For several years in the past many of the confirmed waterfowl hunters have concentrated their efforts on the Canada geese which used the Columbia River and Stratford Lake. Some of these men have told the writer that duck hunting was good only for the first few days of the season and after that, the birds became so wary that they used the large lakes and fed in the grain fields well away from danger. The writer has observed that the same situation still prevails in the area.

When the cattle ranches were condemned and purchased by the U. S. Bureau of Reclamation, the area was available to public shooting. This shooting was heavy. The *jump shooting* method was used by hunters who walked from pothole to pothole in the more accessible sections or by those that drove jeeps into the more inaccessible parts of the area.

Bag data were collected during the 1950 season by the following methods: 1) personal checks made in the field, 2) daily return cards which were sent to cooperating sportsmen's organizations, and 3) data collected by C. F. Banko, then of the State of Washington Department of Game.

Because of the general inability of hunters to identify the ducks which they shoot (Hansen, 1949) the species reported on the daily return cards were

lumped together with the exception of the mallards, shoveller, and green-winged teal.

Of 125 ducks checked, 35% was mallards, 25% was green-winged teal, and 40% was composed of eleven other species. The rather limited data indicate a success ratio of approximately 1.5 birds bagged per man-day. The greatest success was during the first three days of the season accounting for 75% of the birds checked. The crippling loss in the Potholes was high, perhaps as much as 30% of the number of birds shot. There were many acres of tules into which crippled birds could immediately rush upon recovering from the initial shock of being shot. The cripples lost in the Potholes were undoubtedly eliminated very rapidly by predators. The number of piles of feathers where a predator had eaten a bird were noted to have increased markedly soon after the hunting season opened both in 1950 and 1951. Bond (1939) has pointed out that predators catch many crippled birds during and after the hunting season, but that this type of predation is unimportant to the waterfowl populations because most of these birds would die.

INFLUENCES OF OTHER SPECIES

INFLUENCES ON NESTING

Coyotes (*Canis latrans*), although greatly reduced by poisoning in 1951, were apparently the most common mammalian predator in the area and much nest destruction was directly attributable to this animal. Many of the destroyed nests had the same appearance as that described by Sooter (1946).

Coyote scats were collected during both years of the study. These scats were analyzed using the dry technique described by Martin (1949). The contents of the scats were estimated visually by percentages and the data were recorded.

During the summer months of 1950, 123 fresh scats were collected. The analysis of these scats on a percentage-of-total basis showed a diet of 64% mammal, 30% insect, 4% bird, and 2% plant and miscellaneous. During the summer of 1951, only 25 scats were collected. The analysis of these scats showed the following percentages of total remains: 81% mammal, 13% bird, 1% insect, and 5% plant and miscellaneous. The major individual foods of the coyote as determined by the analysis of these scats consisted of pocket mice (*Perognathus parvus*), deer mice (*Peromyscus maniculatus*), jackrabbits (*Lepus californicus*), and June beetles. Apparently there were fewer beetles available in 1951 than in 1950, since the importance of insect remains dropped from almost one-third in 1950 to an unimportant 1% in 1951. Also the smaller sample in 1951 was probably a contributing factor to this difference. Duck, duck egg shell, and duckling remains were not important percentages, but it must be remembered that the importance of nest destruction cannot be revealed by percentage-of-total data since egg shell remains are not indicative of the amount of food taken or the number of nests destroyed. Rather, the percentage of occurrence would be a more valid criterion to use when considering egg shell remains. Duck egg shell was present in 10% of all scats collected in 1950. In addition, duckling was present in 15%. Some of the scats which contained duckling also contained fragments of egg shell. Nearly 20% of all scats had waterfowl remains in them, some of which probably was con-

sumed as carrion. The population levels of mice and rabbits were sampled and found to be quite high. After considering the data available, it is concluded that the coyote was not an important limiting factor upon the waterfowl populations, but it is suspected that, during periods of low mouse and rabbit populations, coyote predation on nests could be limiting. Even though the coyote populations were considerably lower in 1951 compared to 1950, no apparent increase in waterfowl populations in 1951 could be attributed to this decrease in coyote numbers. Also, the nest mortality was high in 1951 even though there were few coyotes in the area.

The raccoon (*Procyon lotor*) was common throughout the Potholes. Several individuals were observed and tracks were common everywhere along water areas. The analysis of 37 fresh scats collected during the summer of 1950 indicated that the major foods were crayfish and small unidentified fish. Some predation on waterfowl nests was observed, and the scats collected contained small amounts of waterfowl remains.

Imler (1945) found bullsnakes to be an important predator on duck nests on Crescent Lake National Wildlife Refuge in Nebraska. Bullsnakes were often observed in the meadows and were probably responsible for some nest destruction. Both magpies (*P. pica hudsonia*) and ravens (*Corvus corax*) were common and crows (*C. brachyrhynchos*) were rare. Some nests were obviously destroyed by avian predators and were probably the work of these species. The visits to the nests by the observer caused two and possibly three hens to desert. Nests adequately concealed from the human point of view seemed to be as susceptible to destruction as those which were adjudged to be poorly concealed. Hammond (1940) also points this out.

There was an excessively high population of cattle during both years of the study. Cattle were noted to graze every plant in the Potholes which was acceptable as food (including wild rye grass and bulrushes). One waterfowl nest was found destroyed by cattle trampling. The indirect effect of cattle overgrazing on nesting success was difficult to determine. Many of the destroyed nests had their cover markedly reduced by grazing prior to their destruction. Under proper management conditions with proper stocking, the presence of cattle might be beneficial. Bennett (1938) has reported on an experiment on the effects of grazing pressure on waterfowl nesting. C. F. Yocom (personal communication) was told by a local cowhand that as many as 300 waterfowl nests were found a year in the irrigated hay meadows of the cattle ranches when they were in full operation. While this figure may be an exaggeration on the part of the cowhand, there is little doubt that nesting conditions were considerably better under proper management than during the period of this study. Cattle severely overgrazed *Scirpus acutus* cover wherever they could reach it. The direct effect of this overgrazing on the waterfowl populations is unknown.

In view of the writer's findings it was difficult to determine the effects of nest destruction on the waterfowl populations in the Potholes. Early nests were more susceptible to destruction than later ones. Most early nests were located in scattered shrubby cover or wild rye grass cover. Apparently predators learned to search in the individual clumps of vegetation where the early nesting ducks built their nests. Of the 13 nests located in wild rye grass, only one was successful. After the *Juncus* meadows obtained a growth of 12-18

inches in mid-May, they became available to nesting waterfowl, and since they created extensive areas of possible nesting cover, a predator would have had to search more diligently to find the same number of nest sites in the same amount of time even though there were more ducks nesting at the later date. Undoubtedly other food sources became more available to the predators at this time of the year, thus reducing predation of pressure on nests. Possibly, in years of low prey populations, predation on nests could become an important limiting factor, but considerable study is necessary to establish this thought with any reasonable degree of assurance.

OTHER INFLUENCES

Beaver (*Castor canadensis*) indirectly benefited waterfowl by the construction of dams which formed potholes along streams. Such potholes remained ice-free longer than most and were thus utilized by wintering ducks as well as the summer residents.

Muskrat (*Ondatra zibethica*) houses were utilized as loafing sites by many species of waterfowl. This species as well as mice, rabbits, and other small mammals acted as a buffer between waterfowl and predators.

FOOD-HABITS STUDIES

One can find much information in the literature concerning the food habits of waterfowl. Among this literature, the works of Martin and Uhler (1939), Cottam (1939), Martin, Zim, and Nelson (1951), and Jones (1940) are outstanding on a nation-wide basis. Yocom (1951) reported on food habits work done in the State of Washington. McAtee (1939) has published on the propagation of waterfowl food plants.

During the present study, 60 duck and three coot stomachs were collected from birds shot during the hunting seasons of 1950 and 1951. C. F. Banko of the State of Washington Department of Game collected several mallard stomachs on Moses Lake and Derek D. Earp provided one harlequin stomach. Two stomachs were obtained from local sportsmen. The remainder of the material was collected by the writer or persons that hunted with the writer. The stomachs included 21 mallards, 15 baldpates, 11 green-winged teal, three shovellers, three galwalls, three buffle-heads, one redhead, one lesser scaup, one harlequin, and three coots.

The contents were dried and later separated with screens and by manual sorting with forceps. Seeds were identified by direct comparison with reference seed collections. Questionable samples were identified by A. C. Martin of the Fish and Wildlife Service at Patuxent Research Refuge, Laurel, Maryland. The volume was measured in cubic centimeters using the water-displacement method. Amounts which measured smaller than .05 cc were recorded as traces. Measurements were rounded off to the nearest .1 cc.

FALL FOOD HABITS OF DUCKS IN THE POTHOLES

The food items found in the 60 duck stomachs are listed in table 4. Based on frequency of occurrence, the family Cyperaceae was the most important, followed by the Gramineae, Potamogetonaceae, Cruciferae, Lemnaceae, Compositae, Haloragidaceae, Polygonaceae, and Amaranthaceae. Based on percentage of total volume, the Cyperaceae was the most important followed by

Gramineae, Potamogetonaceae, Cruciferae, Amaranthaceae, and Haloragidaceae in that order. Cultivated wheat found in several mallards accounted for much of the percentage of total volume for Gramineae. Mallards were observed to do much of their fall and winter feeding in the grain fields where they fed on wheat.

Although a large number of different items was consumed, apparently few were important as foods. Based on frequency of occurrence, the important foods were: *Scirpus*, *Eleocharis*, *Potamogeton*, *Distichlis*, *Nasturtium*, and *Lemna*. Based on percentage of total, the most important genera listed in the order of their occurrence were: *Scirpus*, *Triticum*, *Potamogeton*, *Nasturtium*, *Eleocharis*, and *Distichlis*.

The amount of animal food taken during fall and winter was small. A true evaluation of animal food was difficult to obtain since only the hard parts remained in the samples. Various members of the Mollusca (small snails and fingernail clams) were among the more common animal remains. Amphipods (*Gammarus*) and beetles were quite important also as far as animal food was concerned.

Most of the ducks collected were thought to have fed in the Potholes. For the most part, the samples show the utilization of foods which grew in the study area.

The coots were observed to do much diving for their food; based on the many field observations and food remains found in three stomachs, it is suspected that they fed largely on the green vegetation of submerged aquatic plants such as *Potamogeton*, *Ruppia*, and *Myriophyllum*.

PROBABLE EFFECTS OF FLOODING AND SUGGESTIONS FOR MANAGEMENT

No one can predict with absolute certainty the effects that will take place when the flooding of the Potholes area is completed.

TABLE 4.—Foods found in 60 duck stomachs collected in the potholes and at Moses Lake during fall

Species	Frequency	Volume in cc	Percent of Total Volume
Potamogetonaceae			
<i>Potamogeton</i> spp.	11	3.6	5.4
<i>Potamogeton pectinatus</i>	4	4.0	6.1
<i>Ruppia maritima</i>	1	trace	trace
<i>Zannichellia palustris</i>	1	trace	trace
Gramineae			
<i>Triticum aestivum</i>	3	15.1	22.8
<i>Distichlis stricta</i>	6	2.1	3.2
<i>Echinochloa crusgalli</i>	2	trace	trace
<i>Panicum</i> spp.	1	trace	trace
<i>Agrostis</i> spp.	2	.1	.1
Unidentified Gramineae	3	trace	trace
Cyperaceae			
<i>Carex</i> spp.	3	trace	trace
<i>Scirpus acutus</i>	45	18.6	28.2
<i>Scirpus nevadensis</i>	7	6.0	9.1
<i>Scirpus americanus</i>	9	.2	.3
<i>Scirpus paludosus</i>	3	1.0	1.5
<i>Eleocharis</i> spp.	12	.1	.1

TABLE 4.—(continued)

Species	Frequency	Volume in cc	Percent of Total Volume
<i>Eleocharis macrostachya</i>	24	2.5	3.8
Unidentified Seed	1	trace	trace
Lemnaceae			
<i>Lemna</i> spp.	6	trace	trace
Juncaceae			
<i>Juncus</i> spp.	1	trace	trace
Polygonaceae			
<i>Polygonum</i> spp.	2	trace	trace
<i>Polygonum lapathifolium</i>	2	.2	.3
Amaranthaceae			
<i>Amaranthus</i> spp.	4	1.0	1.5
Ceratophyllaceae			
<i>Ceratophyllum demersum</i>	2	.2	.3
Ranunculaceae			
<i>Ranunculus cymbalaria</i>	1	.2	.3
Cruciferae			
<i>Nasturtium officinale</i>	6	6.7	10.1
<i>Brassica</i> spp.	1	trace	trace
Rosaceae			
<i>Rosa</i> spp.	2	trace	trace
<i>Crataegus</i> spp.	1	trace	trace
Leguminosae			
<i>Melilotus</i> spp.	3	trace	trace
Haloragidaceae			
<i>Myriophyllum</i> spp.	1	trace	trace
<i>Myriophyllum exalbescens</i>	2	.3	.5
<i>Hippuris vulgaris</i>	2	trace	trace
Onagraceae			
<i>Epilobium</i> spp.	1	.4	.6
Convolvulaceae			
<i>Cuscuta</i> spp.	2	.2	.3
Compositae			
<i>Cirsium</i> spp.	3	trace	trace
<i>Cirsium lanceolatum</i>	3	.2	.3
Total plant material		62.7	94.8
Animal Life			
Unidentified Invertebrate	2	trace	trace
Unidentified Snail	1	trace	trace
<i>Physa</i> spp.	3	.1	.1
<i>Planorbis</i> spp.	6	trace	trace
Unidentified Mollusca	3	.8	1.2
<i>Sphaerium</i> spp.	2	.2	.3
<i>Musculium</i> spp.	1	trace	trace
Unidentified Crustacea	4	trace	trace
Ostracoda	5	trace	trace
<i>Gammarus</i> spp.	5	1.1	1.7
Unidentified Insect	3	trace	trace
Coleoptera	10	1.2	1.8
Locustidae	1	trace	trace
Unidentified Diptera	2	trace	trace
Tendipedidae	2	trace	trace
Unidentified Fish	2	trace	trace
Total animal material		3.4	5.1
Total		66.1	99.9

The first and foremost change that will take place is obvious. The existing vegetation will be killed by the rising waters. Whether or not new aquatic vegetation will form on the edges of the new lake depends on the water-level control methods employed by the irrigation project personnel. The writer has been informed that the annual vertical fluctuation in the reservoir will range as much as 30 feet. The water levels are to be the highest in spring and the lowest in fall. If this is the case, it is almost certain that there will not be a new vegetation complex established on the edges of the new lake. The destruction of these plants will materially harm conditions for waterfowl production as a consequence of the loss of nesting cover, brood cover, and food plants. Even if vegetation does develop along the shoreline of the new lake, it is likely that the area would not support as high a breeding population as during this study. Leopold (1933) has pointed out the importance of the *edge* in game population and when his *law of dispersion* is applied to the Potholes before and after flooding, it is obvious that the conditions as they were before flooding would be the more favorable to waterfowl.

Possibly the existence of the proposed reservoir will raise the underground watertables in the immediate vicinity enough to be sufficient to form a new potholes area in the now dry sand dunes to the west of the present region. Part of the water which comes into the reservoir will be waste water from the irrigation of land to the north and west. This waste water will be directed into the reservoir through the Winchester Wasteway which crosses the sand dunes west of Moses Lake. Since the natural drainage of the region is to the southeast, it is possible that this wasteway may aid in the formation of new potholes in the western dry dunes by supplying water to the underground water tables through seepage. Further study is needed to determine the permanency of any potholes and the size of such an area.

Even though little production can be expected from the proposed reservoir, the very size of the lake will act as a refuge where birds will be able to rest relatively safe from gun pressure but from which they will be required to fly to feed in smaller and more accessible areas where they will be available to hunters. The lake, then, should serve to retain ducks in the general region longer thus making them more available to hunting over a longer period of time as well as increasing the carrying capacity of the winter range in the area. It will probably be necessary for local management personnel to purchase lands near the lake for the cultivation of food plants as a means of reducing expected crop damage in the area.

A study should be undertaken to determine the value of the many miles of irrigation canals and wasteways which will accompany the Columbia Basin Project. The small diversified farms and many waterways that will be established can be expected to substantially increase the carrying capacity of the wintering range in this section of the state. These canals and bodies of water should serve to scatter ducks from concentration areas of large lakes and thus make them available to hunting as well as reducing the danger of depredation on crops near the larger lakes. These canals will probably be of little value from a production standpoint.

A waterfowl research project in the Grand Coulee region should include well operated banding stations to determine the status of this important segment of Washington's waterfowl populations.

A public shooting area would be desirable in the Moses Lake vicinity. The shooting on such an area should be supervised and bag checks should be obtained. The sportsmen of the region should be educated as to waterfowl needs in the area and their aid should be enlisted with definite projects as a means of arousing their interest in something besides killing ducks. Food-habits studies should be made of the waterfowl shot to determine their use of the surrounding irrigated farm lands.

SUMMARY

The vegetation of the Potholes area was arranged in zones along a moisture gradient. These zones from dry to wet were: 1) no vegetation on high, dry, shifting sand dunes; 2) *Psoralea* on the windward faces of lower shifting dunes with sand dock and willows on the leeward faces; 3) saltgrass-Nevada clubrush meadows; 4) Baltic rush-sedge meadows; 5) bulrush-cattail; and 6) submerged aquatic plants.

The potholes area as a waterfowl winter range was acceptable to those species which are adapted to its winter climate, the mallard being the most abundant winter resident.

Permanent and temporary potholes (800-1000); flooded flats, and creeks were used as territorial sites. Territories included a water area, one or more loafing sites, a nearby resting cover, and in some instances, a feeding area. Defense of territory varied with the species and individuals.

Nesting extended from April until late August. Nesting sites depended upon available cover, wild rye grass, *Juncus*, and bulrushes being primarily used. Nearly two thirds of all nests were within 30 feet of water. Predation was the major factor of nest failure.

The brood season extended from April to September. Six major cover types were used by broods in order of their importance were *Scirpus acutus*, *Juncus balticus*, open water, *Typha latifolia*, *Scirpus americanus*, and *Salix*. Potholes with heavy infestations of carp were little used by broods. Reduction in brood size occurred in the first two weeks after hatching.

Nest predation by coyote, destruction of cover by cattle, and high breeding populations of coots were some apparent factors serving to limit duck populations by making nesting and brooding areas less desirable. Activities of beaver and muskrat were beneficial to waterfowl by providing ponds and loafing areas.

The mallard, Canada goose, green-winged teal, ruddy duck, baldpate, and coot were important species in both spring and fall migrations.

Flooding of the Potholes area will result in the destruction of one of central Washington's major waterfowl breeding areas.

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Ovarian Egg Complements and Nests of the Two-Lined Salamander, *Eurycea b. bislineata* X *cirrigeria*, From Southeastern Virginia*

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Recent study of the large ovarian egg complement of *Eurycea bislineata rivicola* Mittleman, by Wood and Duellman (1951:181), showed that gravid females may contain as many as 92 eggs ready for laying prior to the beginning of the nesting season. The maximum number reported in a nest deposited by one female, 50 eggs (H. H. Wilder 1899:235), is far short of the maximum number of larve ova present in some gravid females. Although Wilder (*ibid*) was referring to the eastern subspecies, *E. b. bislineata* (Green), this difference raises the question of the relationship reported to exist between number of ovarian eggs and the number of eggs in nests. I. W. Wilder (1924:77) observed that the number of eggs in nests of *bislineata* is consistent with the numbers of large ova in gravid females from the same region.

Reported here are the numbers of large ova in 41 gravid females, and the number of eggs in 29 nests of the two-lined salamander, *Eurycea b. bislineata* X *cirrigeria*. Females and nests were collected from the same regions on the Virginia coastal plain, principally in the vicinities of Yorktown and Williamsburg.

The females were collected from springs and seepages during the winter months (largely January and February) in 1949, 1950, and 1951. These specimens were promptly preserved, and the ovaries were dissected out after hardening. The ovaries contained large yellowish yolk-filled ova, (1.5 to 2.5 mm in diameter) and small white translucent ova (0.3 to 0.75 mm in diameter). Intermediates between these two size-groups of ova were not noted, and only large ova were counted. The 41 females contained a total of 2,931 large ova, with complements ranging from 29 to 115, mean 71.5 ± 20.8 . Snout-vent measurements were based on the straight-line distance from the anterior tip of the snout to the inner posterior margin of the cloaca. The females ranged in snout-vent length from 36 to 50 mm, mean 43 ± 3.4 . Length measurements were plotted against counts of ova (fig. 1). The correlation between snout-vent length and the number of large ova was evaluated by the product-moment method. It was found that $r = 0.695$, $t = 6.23$, indicating that there is considerably less probability than one chance in several hundred that these data do not demonstrate a significant correlation. The number of large ova is related to the length of the female; generally, longer females contain more ova.

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The persistence of bilateral symmetry in the ovaries of animals with elongate trunks is a primitive condition. To evaluate the extent of unilateral tendency in the distribution of the large ova in the ovaries of these salamanders, the complements of the right and left ovaries were counted separately. The 41 right ovaries contained 1,484 large ova (range: 15 to 60, mean: 36.2 ± 10.4); left ovaries, 1,447 ova (range: 14 to 63, mean: 35.3 ± 10.6). Right ovaries plotted against left ovaries (fig. 2) show no unilateral tendency; when one ovary contains a large number of yolk-filled ova, the other ovary contains a fairly similar number.

Nests were collected from January 23rd to March 12th, 1949, and from January 29th to April 16th, 1950. Three nests contained more eggs than the maximum number of large ova found in a female, and were regarded as the product of more than one female. These nests contained 257, 180, and 134 eggs. Other instances of egg groups deposited by more than one female have been reported by Weber (1928:108) and Bishop (1941:283). The other nests contained numbers of eggs not exceeding the maximum number of large ova found in females from the same region. They contained a total of 1,360 eggs, nest complements ranging from 18 to 96 eggs, mean 52.3 ± 18.1 . These nest counts are compared with large ova complements in fig. 3.

Discussion.—The mean number of large ova in gravid females exceeded the mean number of eggs in nest groups by 36.6 per cent. This difference results from the dissimilar modes and central tendencies, not from the presence of a few abnormally large or small counts of either ova or eggs. These data fail to substantiate I. W. Wilder's (1924:77) report of equivalence in numbers of eggs in nests and large ova in gravid females collected from the same region.

Three different ranges in the number of eggs found in nests of *Eurycea*

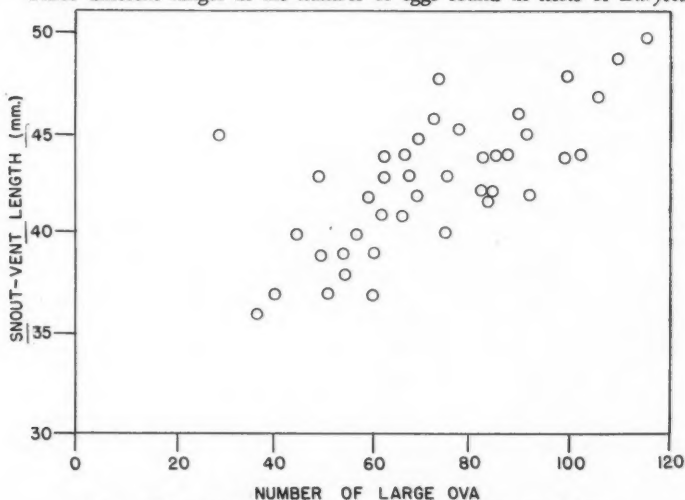


Fig. 1.—The relation between snout-vent length and number of large ova in 41 *Eurycea b. bislineata* X *cirrigera*

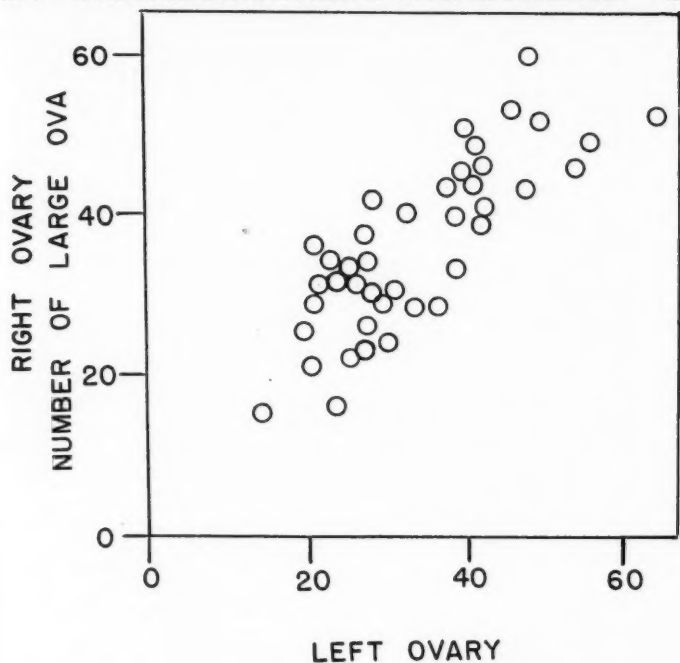


Fig. 2.—The relation between the number of large ova contained in the right and left ovaries of 41 *Eurycea b. bislineata* X *cirrigera*

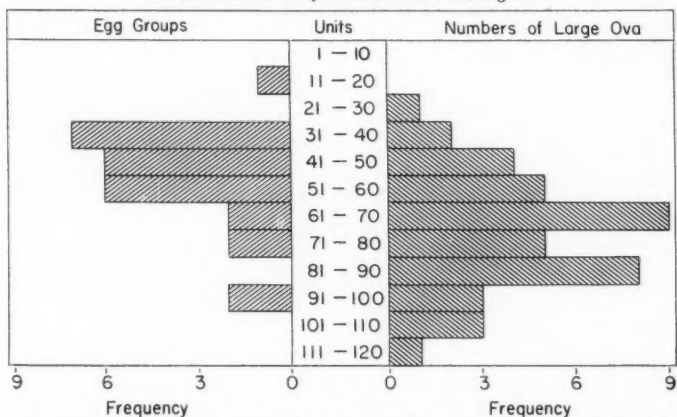


Fig. 3.—A comparison of the numbers of large ova in 41 *Eurycea b. bislineata* with the number of eggs in 26 nests from the region in which the gravid females were collected.

b. bislineata have been reported: 12 to 36 eggs (I. W. Wilder *ibid*), 18 to 43 eggs (Bishop *ibid*), and 30 to 50 eggs (H. H. Wilder *ibid*). These differences were presumed to be related to differences in the average size of the females in the areas in which the eggs were studied, but more likely result from the effects of environmental factors on the egg-laying behavior.

A similarity is noted in the relation of large ova complements to snout-vent lengths in *Eurycea b. bislineata* X *cirrigera* (fig. 1), and in *Eurycea bislineata rivicola* Mittleman (Wood and Duellman *ibid*). These studies show that the range in number of large ova in a gravid female is rather broad for females of any size, but that higher minimum and maximum numbers of ova are found in larger females. Females containing more than 50 large eggs, the maximum number previously reported in nests deposited by one female, formed a large population of the specimens studied: 85.6 per cent in *bislineata* X *cirrigera*, and 43.1 per cent in *rivicola*. These data raise doubts as to the validity of Bishop's supposition (1941:283) regarding nests containing more than 50 eggs as likely to be the product of more than one female. Wood (1949:62) considers a nest of 87 eggs of *Eurycea bislineata wilderae* Dunn as the product of one female because, among other reasons, it consisted of the possible ovarian complement of one female. Thus we regard all nests containing 115 or less eggs as the possible product of one female.

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Two New Species and a New Variety in the Genus *Arachnophroctonus* (Hymenoptera: Psammochari- dae) With Photomicrographs of the Geni- talia and Subgenital Plate for the Genus and for Several Other Species

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Arachnophroctonus is used here as characterized by Evans (1951) in his monograph, except that I accord it generic rank, while Evans considers it to be a subgenus of *Anoplius*. In this sense the genus includes those species previously included in *Psammochares* (*Pompilus*) which have stout, backward directed bristles on the pygidium of the female, and which have all the claws cleft in the male. Evans states that an invariable character in separating this genus is that the basal vein is either interstitial or the transverse median meets the media slightly before the basal. Evans did an excellent job in removing the confusion existing in this group and the writer agrees with him fully in his presentation of the genus, except in a few minor cases. Two new species and a new variety, however, were discovered in my study of this family and the descriptions follow.

Photomicrographs of the male genitalia and subgenital plates of all the species are presented, as well as *Anoplius depressipes* Banks (figs. 5, 10), *A. fulgidus* (Cr.) (figs. 20, 27), (which were not available when the paper (Dreisbach, 1950) on that genus was published) and also *Anopliodes parsoni* Banks (figs. 21, 22). In comparing the drawings in Evans' paper with the photomicrographs, certain differences are noticeable.

In the case of *Anopliodes parsoni* the errors which arise in making drawings (in spite of great care) are very evident. The parapenial lobes seem to be almost as long as aedeagus in the photo and somewhat heavier than in drawing, while the parameres have almost parallel sides whereas the drawing shows them becoming narrower from base to tip. Also, the drawings of the subgenital plates of *A. americanus* and *A. apiculatus* groups do not quite agree with the photos.

Arachnophroctonus occidentalis n. sp.

Figs. 13, 17

Holotype male.—Completely black; white sericeous hairs on clypeus, face and inner orbits to just above bases of antennae; in reflected light the whole body appears purple-tinted when turned at angles and these tints appear and disappear as the body is turned; considerable upright black hair on head, under head and underside of neck with a few on fore coxae; a very heavy hair brush on fourth and fifth sternite, the fifth sternite telescoped within the fourth, and this hair brush continues over both sternites; when seen at right angles no upright hair on dorsum of propodeum but long upright hairs on the edges to the sides; when seen from the side the clypeus is bulged in the middle, whole front and vertex just barely visible above the eye, posterior orbits very narrow just about one-third as wide as eye; when seen from in front, ocellar triangle just barely above rest of vertex, which is level with eye; eyes very slightly emarginate about middle of front, eyes at vertex

same distance apart as clypeus; fore ocellus slightly more than its diameter from the laterals and these as far apart as their distance to eye margin; a slight pit in front of fore and at side of the lateral ocelli; comparative lengths of first four and last two antennal joints 7:2.2:6:8:6:6, thus the third joint is slightly shorter than the first, the ultimate joint is of smaller diameter than preceding and tapers to a point; pronotum angulate; wings dark-colored; marginal cell very short, only three-fifths as long as its distance to wing tip; second cubital cell somewhat rectangular, but slightly shorter on marginal than on cubital vein, third cubital cell petiolate; first recurrent vein meets the second cubital cell almost at apex, while the second intercubital meets the third beyond the middle; basal and transverse veins in fore wing interstitial, while the subdiscoidal in rear wing is basad of cubitus; hair brush on fourth sternite with longer hair than that on fifth; no spines on femora, several spines on fore tibiae and the other two pair well spined; only the basitarsi with spines on dorsal surface, the others only spined on ventral surface with the last joint of all the legs almost devoid of spines beneath, all the joints with fairly long spines at tips; all the claws cleft; longer spur of posterior tarsi three-fifths as long as its metatarsal joint; comparative lengths of joints of posterior legs starting with femur, 30:35:37:12:9:6:7.

Length: Head and thorax, 3.98 mm, abdomen 3.4 mm, fore wing 7.0 mm, rear wing 5.6 mm, genitalia length 1.19 mm, width 0.73 mm, subgenital plate 1.0 mm, width 0.46 mm.

Holotype male: Redwood City, Environs S.M.Co., Cal., VIII-31-28, Carl D. Duncan 1498-17 (Cal. Acad. of Sciences).

Paratype males: 14, same data, 2 (RRD), 1 (Evans), 1 (MCZ), 1 (AMNH), 1 (Nat. Mus.), 8 (San Jose State College).

All of the paratypes have almost identical measurements as the holotype. This species is very similar to *P. relativus* (Fox), but is smaller in size, the volsellae with much more of the ventral surface free of hair, and not pointed at apex but obtuse, and has a row of hairs on inner edge almost to tip, the parapenial lobes are noticeably longer than the aedeagus and very wide, while in *relativus* they are just barely longer and much narrower, and the last ventrite is almost parallel-sided where *relativus* is more rounded. In addition, there are no long hairs at base of volsellae while *relativus* has four or five long hairs, the third cubital is petiolate, and marginal cell is shorter than its distance to wing tip, while in *relativus* the third cubital is widely open and the marginal cell is longer than its distance to wing tip.

Arachnophroctonus gaigei n. sp.

Figs. 4, 11

Holotype male.—Completely black, with sericeous hairs on clypeus, face and inner orbits to above base of antennae, sparse, upright, black hair at base of clypeus, front, vertex, mouth parts, under head, fore coxae, pronotum, and more numerous ones on propodeum; hardly any hair on abdomen except on the V-shaped notch and apical corners of sixth ventrite; when seen from the side, the clypeus is bulged in center, the front just back of bases of antennae considerably raised above the eyes, but the vertex and upper front only slightly above eyes, posterior orbits hardly visible, no more than one-fifth width of eye, with a faint whitish line on upper part next to eye, head lenticular; when seen from in front, vertex is raised in a smooth arch above eyes, a slight emargination on inner orbits at middle of front, the eyes just barely farther apart at vertex than at clypeus, the length of head six-sevenths as long as greatest width across eyes; comparative lengths of first four and last two antennal joints, 9:2.5:9:7.5:5:7.5; propodeum abruptly declivous at posterior edge, concave on posterior surface and with the outer posterior corners appearing as knobs when seen from above and at an angle; wings dark brown all over, the marginal cell large and longer than its distance to wing tip; the second cubital cell twice as long on cubital vein as on marginal vein, third cubital cell widely open on marginal and only one-third as long on this vein as on the cubital vein, a little more than one-half as wide on marginal vein as the second cubital cell; first recurrent vein meets the second cubital cell at apical third, and the second recurrent meets the third cubital cell at middle; basal veins in fore wings interstitial and in the rear wings the subdiscoidal is basad of the cubitus; legs spined just about like those of *A. occidentalis*; longer spur of posterior tibiae two-

thirds as long as its metatarsal joint; comparative length of joints of posterior legs starting with femur; 33:40:32:15:12:7:10; claws all cleft.

Length: Head and thorax 4.7 mm, abdomen 5.7 mm, fore wing 8.6 mm, rear wing 6.6 mm, genitalia length 1.26 mm, width 0.74 mm, subgenital plate length 0.920 mm, width 0.80 mm.

Holotype male: Phantom Lake, Davis Mts. Fort Davis Quad., Texas, VI-9-1916, F. M. Gaige, No. 120. (MZUM)

This species is different than any other species of the genus by virtue of its very narrow, almost linear volsellae, which come to a point. The subgenital plate approaches that of *A. bellicosus* Banks, but is more pointed and more wedge-shaped.

Arachnophroctonus apiculatus hondurensis n. var.

Figs. 25, 28

Holotype male: Head, thorax, base of first abdominal tergite, posterior edge of third tergite and last four tergites black, the apical third of first segment, all the second, and basal half of third segment red; the whole body clothed with coarse, silvery pubescence; only a few long hairs on vertex, clypeus, under head, on shoulders above fore coxae, fore coxae and a few on pronotum; when seen from the side the front just above antennae and the nearer ocellus visible, clypeus almost flat, posterior orbits about one-seventh width of eyes; when seen from in front, inner orbits parallel, middle interocular distance five-ninths that of transfacial distance, head just about as wide as long, clypeus one-half as long as wide, and rounded in front in a smooth curve; fore ocellus more than its diameter from the laterals and these closer together than their distance to eye margin; ratio of lengths of first four antennal segments 2.5:0.6:2.0:2.0, the rest of antennae lost, the third joint twice as long as thick; pronotum not angulate behind; propodeum short, in a smooth curve without any declivity behind; wings hyaline smoky beyond the cubital cells; marginal cell very short, shorter than its distance to wing tips; second cubital cell longer than the third which is sessile on the marginal vein, both recurrent veins meet the second and third cubital cells in the middle; basal and transverse veins in fore wings interstitial, as well as cubitus and subdiscoidal in rear wings; legs almost bare of spines, a few on middle and posterior tibiae, very few on fore tarsi, the other tarsi lost; the last joint of fore tarsi just barely asymmetrical slightly bulged on inner side, fore claws split; subgenital plate different than that of the other varieties, it has a definite bulge almost a blunt tooth at tip and the tip each side slightly convex; the hairs on volsellae of genitalia are thick and the blunt tips are bare of hair.

Length: Head and thorax 2.70 mm, abdomen 3.0 mm, fore wing 4.3 mm, rear wing 3.0 mm, genitalia length 0.65 mm, width 0.35 mm, subgenital plate length 0.80 mm, width 0.35 mm.

Holotype male: Pto. Castilla, Rep. Honduras, III-24-1924, J. Bequaert (MCZ).

KEY TO MALES OF MARGINALIS GROUP OF ARACHNOPHROCTONUS HOWARD

1. Sternites four and five with hair brushes 2
1. Sternites four and five without hair brushes 3
2. Parapenial lobes very heavy, longer than aedeagus; tip of volsellae with much longer bald space; propodeal declivity not so abrupt, posterior outer corners not protuberant, and posterior surface not concave (figs. 13, 17) *occidentalis*
2. Parapenial lobes much more slender and just about as long as aedeagus, tip of volsellae with bald space shorter, propodeal declivity abrupt on posterior edge, posterior sides protuberant, concave on posterior surface (figs. 3, 8) *relativus*
3. Propodeal declivity almost vertical, with posterior sides protuberant, posterior surface slightly concave; vertex broad (1.2 x interocular) or if narrower with volsellae very narrow and no long, heavy hairs on parameres 4
3. Propodeal declivity not vertical, with a more gradual slope and the posterior sides not protuberant, posterior surface not concave, vertex narrower and not with assemblage of characters above.
4. Vertex narrower than 1.2 times lower interocular distance; volsellae very narrow, parameres longer than the parapenial lobes; front less than 0.60 times the transfacial distance and only slightly less than 1.2 times lower interocular distance (figs. 4, 11) *gaigei*

4. Vertex wider than 1.2 times lower interocular distance; volsellae much wider; parameres hardly longer than parapenial lobes, front 0.63 to 0.67 times transfacial distance and 1.2 times the lower interocular distance *xerophilus*
5. Second abdominal tergite, and often more of abdomen marked with orange; subgenital plate wide, flat and with its outer margin fringed with curved hairs, almost rectangular in shape; scape hairy (figs. 1, 6) *marginalis*
5. Entirely black; subgenital plate with a median elevation, and without a fringe of long hairs on margin, short erect hairs on surface; shape not at all rectangular, more ovoid with the tip much narrower; scape not hairy (figs. 7, 18) *bellicosus*

It will be seen from the photos of *Arachnophroctonus americanus americanus* and *A. a. justus* that they can be told apart although the key in Evans (1951) says that these males cannot be separated. The genitalia and subgenital plates of *A. a. trifasciatus* are not available. The two mentioned can be separated as follows:

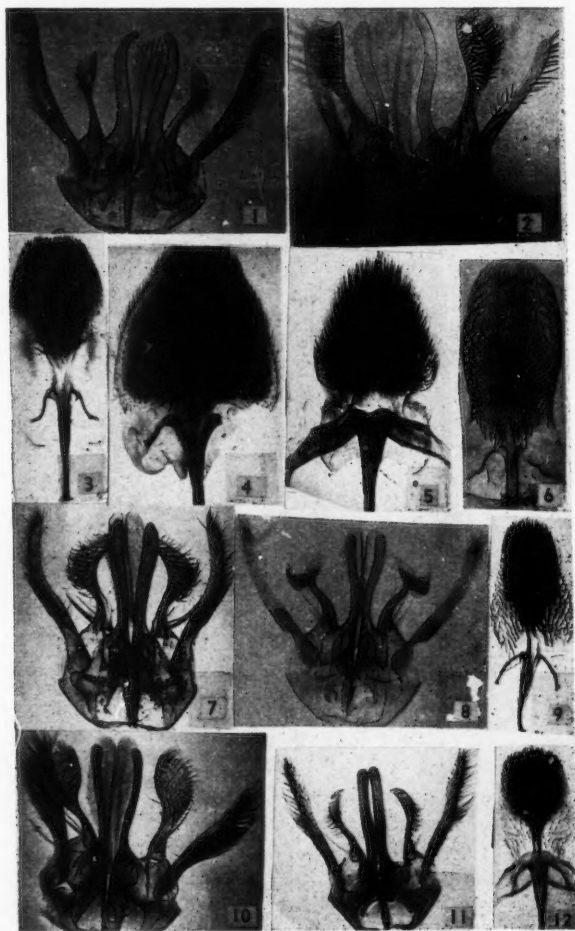
1. Parapenial lobes considerably shorter than the aedeagus, volsellae also somewhat shorter; subgenital plate expanding near base, not quite so broad at tip (figs. 9, 15) *americanus americanus*
1. Parapenial lobes almost as long as aedeagus, volsellae only slightly shorter; subgenital plate not expanding near base, broadest just below middle, only slightly narrower at tip than the broadest part (figs. 12, 14) *americanus justus*

Arachnophroctonus apiculatus apiculatus (Sm.), *A. a. pretiosa* (Banks) and *A. a. hondurensis* can also be distinguished by genitalia and subgenital plate. The genitalia of *A. a. autumnalis* are not available so the status of that variety in this regard is not known. The following key will separate the three varieties named. *A. semirufus* (Cr.) also is not now available in the male.

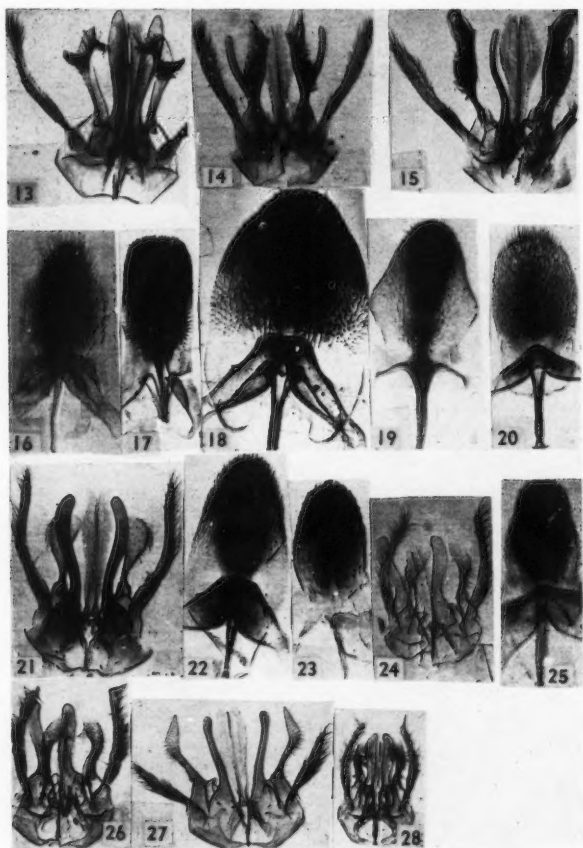
1. Subgenital plate of about even width from bottom to just below tip; plate of about even thickness throughout (evidenced by uniform transmitted color of light); parameres slightly wider and hardly tapering to tip; a slight curvature on inside, near tip of parapenial lobes (figs. 23, 26) *apiculatus apiculatus*
1. Subgenital plate not of uniform width nor of even thickness throughout, not so uniformly haired; slightly tapering to tip 2
2. Subgenital plate rapidly converging to a rounded point at apical third; the basal third almost parallel-sided; parapenial lobes with inside almost a straight line (figs. 16, 24) *apiculatus pretiosus*
2. Subgenital plate widest about the center where it bulges out and then becomes narrower toward base and tip; parapenial lobes slightly curved on inside near tip; subgenital plate with large blunt tooth in center at tip and then slightly convex each side, hardly noticeable in photograph (figs. 25, 28) *apiculatus hondurensis*

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Figs. 1-12.—1. *Arachnophroctonus marginalis*, gen. $\times 35$; 2. *A. moestus*, gen. $\times 66$; 3. *A. relativus*, subg. $\times 48$; 4. *A. gagei* subg. $\times 57$; 5. *Anoplius depressipes*, subg. $\times 33$; 6. *Arachnophroctonus marginalis*, subg. $\times 38$; 7. *A. bellicosus*, gen. $\times 35$; 8. *A. relativus*, gen. $\times 38$; 9. *A. americanus americanus*, subg. $\times 39$; 10. *Anoplius depressipes*, gen. $\times 33$; 11. *Arachnophroctonus gagei*, gen. $\times 35$; 12. *A. americanus juxtus*, subg. $\times 42$.



Figs. 13-28.—13. *Arachnoproctonus occidentalis*, gen. $\times 37$; 14. *A. americanus juxtus*, gen. $\times 44$; 15. *A. a. americanus*, gen. $\times 35$; 16. *A. apiculatus pretiosus*, subg. $\times 50$; 17. *A. occidentalis*, subg. $\times 24$; 18. *A. bellicosus*, subg. $\times 32$; 19. *A. moestus*, subg. $\times 62$; 20. *Anoplius fulgidus*, subg. $\times 40$; 21. *Anopliodes parsoni*, gen. $\times 40$; 22. *A. parsoni*, subg. $\times 40$; 23. *Arachnoproctonus apiculatus apiculatus*, subg. $\times 55$; 24. *A. a. pretiosus*, gen. $\times 50$; 25. *A. a. hondurensis*, subg. $\times 37$; 26. *A. a. apiculatus*, gen. $\times 50$; 27. *Anoplius fulgidus*, gen. $\times 40$; 28. *Arachnoproctonus apiculatus hondurensis*, gen. $\times 60$.

The Ant Larvae of the Myrmicine Tribes Meranoplini, Ochetomyrmicini and Tetramoriini

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Tribe MERANOPLINI Emery

This is a little-known tribe of about 70 species in eight genera. *Meranoplus* is the largest, with 40 species (mostly in Australia); *Calyptomyrmex* musters 14; the remaining genera contain only a single rare species each. Many species of *Meranoplus* are harvesters; their workers move very slowly and "feign death" readily when disturbed. The Meranoplini occur only in the Old World Tropics.

Genus MERANOPLUS F. Smith

Body hairs moderately numerous and of one type: simple and flexible. Cranium subrectangular in anterior view, slightly longer than broad. Head hairs moderately numerous and simple. Antennae small. Labrum small and feebly bilobed; posterior surface sparsely spinulose. Mandible subtriangular in anterior view; apex slightly turned medially and forming a sharp-pointed tooth; middle half of the anterior surface of inner border blade-like, furnished with a few ridges (or grooves?) and sometimes bearing one or more small denticles. Maxillary palp a low knob bearing five sensilla. Labial palps each represented by a cluster of five sensilla; an isolated sensillum between each palp and the opening of the sericteries. Hypopharynx sparsely spinulose, the spinules minute and in a few long subtransverse rows.

MERANOPLUS OCEANICUS F. Smith

Pl. I, figs. 16-18

Leg, wing and gonopod vestiges present. Body hairs moderately numerous, simple and flexible, 0.054-0.245 mm long. Cranium subrectangular in anterior view, slightly longer than broad. Head hairs moderately numerous, simple, slightly curved, minute to long (0.018-0.14 mm). Antennae small; each with three sensilla, each of which bears a minute spinule. Labrum small, breadth 2× length, feebly bilobed due to a median impression of the ventral border; slightly narrowed dorsally; anterior surface of each lobe with 5-7 minute (about 0.009 mm) hairs and/or spinulose sensilla; ventral border of each lobe with a cluster of two or three sensilla; posterior surface with a few subtransverse rows of rather sparse minute spinules; posterior surface of each half with a cluster of two or three sensilla and three isolated sensilla. Mandibles moderately sclerotized; subtriangular in anterior view, apex slightly turned medially and forming a sharp-pointed tooth; middle half of anterior surface of inner border blade-like and furnished with a few ridges (or grooves?), sometimes bearing one or more small denticles. Maxillae with the apex paraboloidal; palp a low knob with five sensilla, four of which bear a spinule each; galea a frustum with two apical sensilla. Labial palps each represented by a cluster of five sensilla, four of which bear a spinule each; an isolated sensillum between each palp and the opening of the sericteries; the latter a short transverse slit. Hypopharynx sparsely spinulose, the spinules minute and arranged in a few long subtransverse rows. (*Material studied*: seven tattered integuments from New South Wales.)

Tribe OCHETOMYRMICINI Emery

This is a small Neotropical tribe of ten species—two in *Ochetomyrmex* and eight in *Wasmannia*. *W. auropunctata* "has recently become established in southern Florida. It is not surprising that this insect should have made its appearance there, since it has been carried all over the tropics in both the Old and New World. Moreover, *auropunctata* appears to be an exceedingly adaptable species as far as the type of nest site is concerned. M. R. Smith (1936) has pointed out that it will tolerate all sort of nesting conditions from heavy shade to areas of extreme dryness and intense illumination. On the other hand, *auropunctata* shows no such adaptability in the matter of mean yearly temperature. It

requires tropical or subtropical conditions and apparently cannot tolerate the climatic conditions which occur along the Gulf coast. The severity of the sting of this little ant is out of all proportion to its small size. Coupled with its practice of tending various aphids this makes *auropunctata* a rather undesirable addition to our ant fauna."¹

Genus WASMANNIA Forel

Body subcylindrical and rather stout; diameter greatest at the mesothorax, decreasing slightly to the second abdominal somite, increasing slightly to abdominal somite IV, and then decreasing somewhat more rapidly to the posterior end, which is narrowly rounded; prothorax forming a stout and very short neck which is at right angles to the rest of the body. Body hairs sparse, short to long, with the apical portion denticulate. Head hairs few, short to long, with the apical portion denticulate. Antennae small. Labrum small, short and trilobed. Mandibles narrowly subtriangular in anterior view; slightly curved medially; apex forming a rather short acute tooth; a smaller acute subapical tooth; several rather long and sharp-pointed denticles on the inner surface near the base. Maxillary palp a low knob bearing five sensilla. Labial palp a cluster of five sensilla; an isolated sensillum between each palp and the opening of the sericteries. Hypopharynx apparently without spinules but with a few longitudinal ridges near the pharynx.

WASMANNIA AUROPUNCTATA (Roger)

Pl. I, figs. 19-26

Worker larva.—Length about 1.4 mm. Body subcylindrical and rather stout; diameter greatest at the mesothorax, decreasing slightly to the second abdominal somite, increasing slightly to abdominal somite IV and then decreasing somewhat more rapidly to the posterior end, which is narrowly rounded; prothorax forming a stout and very short neck which is at right angles to the rest of the body; anterior end broadly rounded and formed from the dorsa of the prothorax and mesothorax. Anus posteroventral. Leg, wing and gonopod vestiges present. Segmentation indistinct. Mesothoracic spiracle noticeably larger than the others. Body hairs sparse, short to long (0.018-0.135 mm), with the apical portion denticulate. Head moderately large. Cranium transversely subelliptical in anterior view, slightly broader than long, with marked occipitolateral angles. Head hairs few, short to long (0.02-0.088 mm), with the apical portion denticulate. Antennae small; each with three sensilla, each of which bears a rather long spinule. Labrum small and short (breadth $2.7\times$ length), trilobed; anterior surface of each lateral lobe with three isolated sensilla; ventral border of each lateral lobe with one isolated and two contiguous sensilla and a few minute spinules; posterior surface of each lateral lobe with three or four isolated sensilla; entire posterior surface spinulose, the spinules minute and in subtransverse rows. Mandibles moderately sclerotized; narrowly subtriangular in anterior view; slightly curved medially; apex forming a rather short acute tooth; a smaller acute subapical tooth on the inner border; several rather long and sharp-pointed denticles on the inner surface near the base. Maxillae with the apex paraboloidal; palp a low knob with five sensilla, three of which bear a spinule each; galea subcylindrical and slightly curved, with two apical sensilla. Labial palp a slightly elevated cluster of five sensilla, three of which bear a spinule each; an isolated sensillum between each palp and the opening of the sericteries; the latter a short transverse slit. Hypopharynx with a few longitudinal ridges near the pharynx. (*Material studied*: several larvae from Costa Rica, Panama Canal Zone and Puerto Rico.)

Queen larva.—Similar to the worker except in the following details: Length 3.5 mm. Much plumper. Diameter greatest near the posterior end (which is broadly rounded), decreasing anteriorly. No neck, head applied to the ventral surface near the anterior end. Body hairs of two types: (1) on the ventral surface, 0.054-0.108 mm long, with the apical portion denticulate; (2) generally distributed, simple, 0.18-0.216 mm long, flexible. Mandibular teeth vestigial. (*Material studied*: a single larva from Puerto Rico.)

Mann² has collected *Oraesema minutissima* Howard in a hollow twig with a colony of this ant. Presumably the eucharid larvae had parasitized the ant larvae.

Tribe TETRAMORIINI Emery

This is a large tribe of some 200 species in 13 genera. The largest and best known

¹ W. S. Creighton. Bull. Mus. Comp. Zool. Harvard 104:294-295. 1950.

² W. M. Mann. Psyche 25:106. 1918.

genus is *Tetramorium*, with 90 species. It occurs native in all faunal realms except the Neotropical, but several tramp species have spread throughout the tropics of both hemispheres. This genus is perhaps best known because of *T. caespitum*, which is host to parasitic ants of the genera *Anergates* and *Strongylognathus*. This same species has occasionally been reported as a pest destroying the living parts of cultivated plants. Several species are harvesters and a few are house and ship pests in the tropics.

The second largest genus is *Xiphomyrmex* with 47 species and the third *Triglyphothrix* with 31 species. *T. striatidens* is a tropicopolitan tramp which has become established in the southeastern United States. The remaining ten genera are small and rare.

Genus TETRAMORIUM Mayr

Stout, paunchy and rather short; diameter greatest at abdominal somite IV; attenuated somewhat toward either end; prothorax turned ventrally to about 90° and forming a short stout neck; posterior end narrowly rounded; anus ventral. Body hairs moderately numerous. Of two or three types: (1) short, with the tip simple to multifid, the most abundant type; (2) moderately long, with the tip short-branched or denticulate, few or none; (3) long, anchor-tipped, with tortuous shaft, four in a row across the dorsum of each of the anterior four, five or six abdominal somites. Head hairs few, minute to long, with the tip denticulate or bifid. Labrum feebly bilobed; breadth twice the length; posterior surface densely spinulose. Mandibles subtriangular in anterior view; body of mandible terminating in a rather long round-pointed apical tooth; anterior surface projecting inward as a blade, which forms two large teeth. Maxillae bearing a few short rows of minute spinules; apex paraboloidal. Labium with the anterior surface spinulose; palps lateral, each represented by a cluster of five sensilla; an isolated sensillum between each palp and the opening of the sericteries. Hypopharynx densely spinulose, the spinules rather long and arranged in rows; dorsally the rows form a reticulate pattern; ventrally the rows are subtransverse.

TETRAMORIUM CAESPITUM (Linnaeus)

Pl. I, figs. 1-11

Mature worker larva.—Length about 2.7 mm. Stout, paunchy and rather short; diameter greatest at abdominal somite IV; attenuated somewhat toward either end; prothorax turned ventrally to about 90° and forming a short stout neck; posterior end narrowly rounded. Anus ventral. Leg, wing and gonopod vestiges present. Segmentation indistinct. Spiracles small; the mesothoracic the largest; the size decreasing posteriorly. Integument of ventral surface of anterior somites and dorsal surface of posterior somites spinulose, the spinules minute and in short transverse rows. Body hairs moderately numerous but sparse on the ventral surface of the abdomen. Of three types: (1) on the dorsal and dorsolateral surfaces, short (0.027-0.036 mm), with multifid flattened tip, the most abundant type; (2) a few on each somite, moderately long (0.045-0.18 mm), the tip branched; (3) anchor-tipped, with tortuous shaft, long (about 0.3 mm), four in a row across the dorsum of each abdominal somite I-V. Cranium subhexagonal (in anterior view), with the corners rounded. Head hairs few, short to long (0.009-0.08 mm), with the tip flattened and denticulate. Antennae slightly elevated, each with three sensilla, each of which bears a spinule. Labrum twice as broad as long, feebly bilobed, somewhat narrowed dorsally; anterior surface of each half bearing five sensilla; ventral and lateral borders may show a few spinules in short rows; ventral border with two contiguous sensilla on each half; posterior surface densely spinulose, the spinules minute and in short rows; posterior surface of each half with three or four sensilla in an oblique row slanting upward and outward. Mandibles heavily sclerotized, subtriangular in anterior view; body of mandible terminating in a rather long round-pointed apical tooth; anterior surface projecting inward as a blade which forms two large teeth; sometimes a smaller additional tooth is present on the posterior surface. Maxillae with the apex paraboloidal; with a few short rows of minute spinules; palp a skewed peg with five sensilla, three of which are larger and bear a spinule each; galea a taller frustum with two apical sensilla. Labium with the anterior surface spinulose, the spinules minute and in short transverse rows; palps lateral, each represented by a cluster of five sensilla, three of which bear a spinule each; an isolated sensillum between each palp and the opening of the sericteries; the latter a short transverse slit. Hypopharynx densely spinulose, the spinules rather long and arranged in rows; dorsally the rows form a reticulate pattern, ventrally the rows are subtransverse. (*Material studied:* numerous larvae from New York and Turkestan.)

Queen larva.—Generally similar to the worker larva but differing in the following details: Body hairs of three types: (1) dendritic (with long trunk), short (0.018-0.09 mm), the most abundant type; (2) very few, long (0.225-0.45 mm), simple or with the tip branched, (3) anchor-tipped, very long (about 0.45 mm), with sinuous shaft. Head hairs dendritic (with long trunk), 0.027-0.045 mm. Spinules on antennal sensilla rather long. Mandibular teeth longer. Hypopharynx with the spinules not arranged in a reticulate pattern. (*Material studied*: seven damaged integuments from New Jersey.)

Young larva.—Length about 2.1 mm. Generally similar to the mature worker larva, but differing in the following details: Neck slenderer; abdomen more swollen. Anus with a prominent posterior lip. Segmentation more distinct. Antennae frequently with only two sensilla each. (*Material studied*: a few specimens from New York.)

Adlerz, 1886; "The hairy covering on the ventral surface of the larvae is similar to that of the *Anergates* larvae, although the hairs are clearly weaker and less branched; they are also sparser and at times are lacking on some segments. The hairs on the dorsal surface are similar to those on the ventral surface; but scattered in between are to be found a few long hairs which are branched at the ends and also occasionally anchor-tipped hairs" (p. 272). (Translation from the Swedish by Professor Edith E. Larson.) Pl. VII, Fig. 4, two branched hairs; Fig. 4a, anchor-tipped. Internal anatomy is mentioned briefly on page 58.

André, 1881-6, Pl. V, Fig. 5: larva in side view.

DeGeer, 1778, Pl. XLIII, Fig. 18: larva in side view, probably of this species.

Donisthorpe, 1927a: "Yellowish white; whiter and more hairy when young; similar to that of *Anergates*, the head, however, is furnished with short hairs, the short branching hairs scattered over the whole body are not so densely nor compactly branching, and the longer hairs are not serrate. Long anchor-tipped hairs are situated on the dorsal surface of the second to the sixth abdominal segments" (p. 192 = 1915, p. 172). Pl. II (= 1915, Pl. II) includes photographs of large and small larvae in side view.

Donisthorpe (1927b, p. 98) stated that the proctotrupid *Tetramopria donisthorpei* Kief. is probably parasitic on the larvae of this ant.

Escherich refigured (1906, Fig. 32 = 1917, Fig. 38E) Adlerz's drawing of an anchor-tipped hair.

Gösswald (1934/35, p. 125) listed this ant as a mermithid host. Presumably the nematode larvae had been parasitic in the ant larvae.

Hölldobler, 1928, p. 142: "Eine *Anergates-Tetramorium-cespium* Kolonie nahm den Keulen-Käfer (*Claviger testaceus*) auch gerne auf, aber hier zeigte er sich als verheerender Bruträuber, der alle Tage eine Larve oder Puppe auffrass."

Janet, 1897, pp. 11-12: "J'ai vu, de la façon la plus nette, une larve d'ouvrière sucer une petite larve jaune de Coléoptère. La larve de *Tetramorium* n'était pas très éloignée d'avoir atteint sa taille définitive. Elle était suspendue par ses poils d'accrochage contre la paroi du nid, immédiatement sous le plafond en verre. Elle était placée horizontalement, le dos en haut, mais un peu de côté. Au-dessous d'elle, placée tête-bêche, parallèlement à son corps et soutenue en partie par les poils d'accrochage de l'abdomen du *Tetramorium*, se trouvait la petite larve jaune vermiforme, ayant $\frac{1}{2}$ millimètre de diamètre et 2 millimètres $\frac{1}{2}$ de longueur. Cette larve jaune avait certainement été placée là par une ouvrière, car pendant l'emménagement, j'en avais vu une qui introduisait une larve semblable dans le nid. La larve de *Tetramorium* avait sa tête infléchie et appliquée contre la larve jaune. Elle laissait voir, très nettement, sa bouche et ses pièces buccales. Grâce à ces circonstances exceptionnellement favorables j'ai pu examiner, avec une forte loupe, ce qui s'est passé, et cela pendant plus d'un quart d'heure. J'ai d'abord constaté le mouvement incessant de la bouche et vu nettement l'absorption du liquide transparent qui sortait de la plaie. Libre dans sa partie moyenne, la petite larve jaune était soutenue dans sa région céphalique par les poils d'accrochage de l'abdomen du *Tetramorium*. Ce dernier maintenant, au moyen de ses mandibules crochues, l'extrémité anale de sa proie, et cette extrémité était animée d'un mouvement rythmé de balancement résultant des mouvements de succion. Pendant ce repas, et sans que la larve du *Tetramorium* parut en être dérangée, une ouvrière est venue la lécher. Cette ouvrière est allée, ensuite, dégorger de la nourriture contre la bouche d'une larve voisine. Au bout d'un quart d'heure j'ai dû interrompre l'observation parce qu'une ouvrière est venue, malencontreusement, intercaler une nymphe entre la larve observée et le verre. J'ai alors pris la larve avec un pinceau et une petite

suiller et j'ai constaté qu'elle avait ramené sa bouche contre son corps, et que le repas était interrompu. Quant à la petite larve jaune dont j'avais vu le corps bien gonflé au commencement de l'observation, elle était, maintenant, surtout dans la région sucée, flasque et en partie vidée."

Janet, 1904, p. 33: "Les poils à double crochet des jeunes larves de *Tetramorium caespitum* sont pourvus de nombreuses sinuosités qui leur donnent beaucoup d'élasticité. Dans les nids artificiels de cette espèce, j'ai vu fréquemment un grand nombre de petites larves accrochées sur les parois verticales des chambres d'habitation. En examinant, à la loupe, celles des larves, ainsi suspendues, qui sont placées à peu de distance au dessous du verre, on voit, entre leur corps et la paroi du nid, un petit intervalle proportionné à la longueur de leurs poils d'accrochage. Les ancrs de ces poils pénètrent dans les aspérités de la paroi du nid."

Karawaiew (1906, Fig. 12 on p. 373) showed the salivary glands in an outline of the larva. Repeated by Forel (1923, Fig. 11A = 1928, Vol. II, Fig. 133) and by Wheeler (1910, Fig. 124C on p. 222). Referred to by Karawaiew, 1929.

Latreille, 1802, Pl. X, Fig. 63: a crude figure of a larva.

Marlatt, 1898, Fig. 3 on p. 3: e, larva in side view; f, head in anterior view and head hair enlarged. Fig. 3e was repeated by Howard, 1901, Fig. 23.

Mayr, 1855, p. 283: "Im Allgemeinen lässt sich sagen, dass die Larven der Arbeiter die kleinsten, die der Männchen etwas grösser und die der Weibchen gewöhnlich am grössten sind, und die Abweichung in der Grösse ist bei manchen Arten, wie z. B. bei *Tetramorium caespitum* eine sehr beträchtliche."

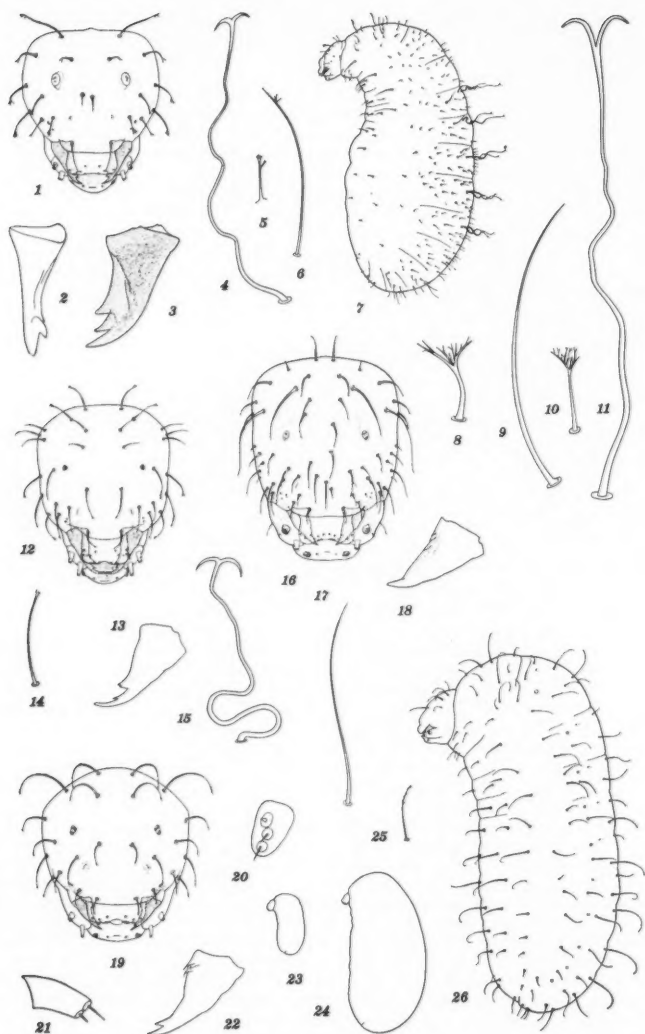
Réaumur, 1742(?). See Wheeler, 1926.

Stärcke, 1939: Internal anatomy of the antenna.

Stärcke, 1948, p. 29-30: "♂. Head wide 0.33, high 0.17 mm. Oncochaeta very long, 255 Micron, Achroch, 91, Microch. 37, i.e. much shorter than with *Myrmica*. The hairs on the head on the contrary are longer, nearly uniformly 201 Micron. Some of them are forked for about one third of their length, the Achroch. on the body mostly have plumose tops. The labium protrudes more and the mandibulae are more massive."

Wheeler (1909) described the larva as "gleaming white" (p. 181), with "pairs of long anchor-tipped dorsal hairs" and also shorter hairs which are branched at the tip. "The anchor-tipped hairs with sigmoid basal flexure are used . . . for fastening the larvae to the lower surfaces of stones, the roots of plants and the walls of the galleries and chambers of the nest" (p. 183). Fig. 2B on p. 182 includes a larva in side view and the two types of hairs enlarged.

Wheeler (1926, pp. 113-114) has reproduced the original French of Réaumur (1742?); his translation (pp. 202-203) follows: "Their larvae are of the kind that I have elsewhere described as bagpipe-shaped, or, if one wishes, they may be said somewhat to resemble a bird without wings, without legs and without feathers. I would only say that their anterior portion forms a kind of birds' neck at the end of which there is a head that might be regarded as terminating in a beak. The body of the larvae is always moist and even sticky. Is this due to the matter which it transpires or does it not rather derive the liquid in which it is bathed from the nurses that care for it? It is certain that they lick the larvae continually. There are sometimes four or five at the same time occupied with licking those which are to become winged ants and which are huge masses in comparison with those of the worker ants. It is more natural to suppose that the ants that lick the larvae endeavour to keep them covered with a liquid that is advantageous to them, than to suppose that they endeavour to withdraw a superfluous liquid from them, that is, to dry them. . . . Besides the advantages accruing to the larvae, this liquid with which their bodies are moistened is convenient for the nurses. Its effects prove that it is viscid. The workers sometimes unite the larvae into a cluster, in which they are all held together by the liquid. I observed the effect of this sticky substance on one occasion of which I shall have to speak. I sometimes saw the greater part of the larvae very far out of the earth and attached to the walls of the beaker. Not only did the viscosity of the substance resist the whole weight of a larva, but often two or three other larvae were glued to it without touching the walls of the beaker at any point." In footnote 116 on page 256 Wheeler commented as follows: "The larvae of *Tetramorium caespitum* are furnished with characteristic hooked and bifurcated hairs, . . . and it is these, and not exclusively the sticky coating noticed by Réaumur, that hold them together in packets."



EXPLANATION OF PLATE I

Tetramorium caespitum (Linnaeus), Figs. 1-11.—1, head in anterior view, $\times 95$; 2, left mandible in medial view, $\times 216$; 3, left mandible in anterior view (shaded to show thickness), $\times 216$; 4-6, three types of body hairs, $\times 185$; 7, worker larva in side view, $\times 24$; 8, head hair of queen larva, $\times 340$; 9-11, three types of body hairs of queen larva, $\times 185$.

Xiphomyrmex turneri Forel, Figs. 12-15.—12, head in anterior view (immature larva),

TETRAMORIUM CAESPITUM PUNICUM (F. Smith)

Apparently very similar to *caespitum* s. str. except in the following details: Spinules on ventral surface of anterior somites only. Body hairs of two types: (1) short (0.018-0.054 mm), with the tip bifid, widely distributed; (2) anchor-tipped with tortuous shaft, about 0.18 mm long, four in a row across the dorsum of each abdominal somite I-V. Head hairs with the tip bifid, 0.018-0.054 mm long. Antennae with two or three sensilla each. Labrum with the anterior surface of each lobe bearing three minute hairs; ventral border with an isolated and two contiguous sensilla on each half. (Material studied: two damaged integuments from Afghanistan, labelled var. *lucidula* Emery.)

Gantes, 1949: "La jeune larve a un corps légèrement arqué, mesure 0 mm. 60. Le corp est nu. Seuls les segments thoraciques sont nets. La tête est déjà différenciée, mais nous l'étudierons chez la larve adulte. Cette larve est massive, subcylindrique. . . . Le corp est couvert par plusieurs sortes de poils. 1. Poils à double crochet, qui sont plantés sur le dos en cinq rangées à partir du premier segment abdominal: il y a quatre poils par rang. Ces poils mesurent 0 mm. 30; ils sont très souples, ont un ressort important et le double crochet est très grand. 2. Poils fourchus, sur les côtés de l'abdomen: ils sont longs, fins, droits et terminés par une minuscule fourche; ils ont 0 mm. 092 de long. 3. Sur le reste du corps, nous avons des poils beaucoup plus courts, 0 mm. 041 et 0 mm. 036, fourchus également, ou bien à trois branches de 0 mm. 050. La tête est bien différenciée, couverte de vingt-six poils fourchus dont les branches parfois se divisent elles-mêmes en deux et de 0 mm. 041 de long. Les pièces buccales n'ont rien de remarquable: le labre a un seul lobe. Les mandibules sont bien formées, brun foncé, mesurent 0 mm. 092; elles ont toujours la même forme" (p. 81). Pl. IV, Fig. 5: mandible, labrum and hairs. Pl. V, Fig. V: larva in side view. Growth pp. 85 and 86.

TETRAMORIUM CAESPITUM SCHMIDTI Forel

Generally similar to *caespitum* s. str. except in the following details: Body hairs of three types: (1) short (0.009-0.054 mm), with simple to multifid tip, the most abundant type; (2) moderately long (about 0.126 mm), with denticulate tip, few; (3) anchor-tipped, with tortuous shaft, long (about 0.3 mm), four in a row across the dorsum of each abdominal somite I-VI. Integument with spinules on the ventral surface of the anterior somites only. Head hairs 0.018-0.054 mm long. Labrum with three hairs and one sensillum on the anterior surface of each lobe; ventral border of each lobe with one isolated and two contiguous sensilla; posterior surface of each half with three or four sensilla in an oblique row slanting upward and outward and also a cluster of two or three sensilla. Maxillary palp with five sensilla, each of which bears a spinule. (Material studied: ten larvae from Iran.)

TETRAMORIUM GUINEENSE (Fabricius)

Mature worker larva.—Body length about 2.7 mm. Generally similar to *caespitum*. Abdomen more slender; midventral surface of each abdominal somite I-VI with a boss; bosses decreasing in size posteriorly; anus posteroventral with a prominent posterior lip. (But these differences may be due to maturity or nutrition.) Body hairs of two types: (1) generally distributed, short (0.036-0.17 mm), with short-branched tip (simple-bifid or bifid with the branches denticulate or denticulate or multifid), the most abundant type; (2) long (about 0.4 mm), anchor-tipped with tortuous shaft, four in a row across the dorsal surface of the metathorax and each abdominal somite I-V. Head hairs with multifid tip. Labrum subrectangular with the ventral corners rounded, about 1.6× as broad as long; anterior surface with a few short rows of minute spinules near the ventral border;

×95; 13, left mandible in anterior view (immature larva), ×185; 14 and 15, two types of body hairs of next instar larva, ×95.

Meranoplus oceanicus F. Smith, Figs. 16-18.—16, head in anterior view, ×86; 17, body hair, ×235; 18, left mandible in anterior view, ×185.

Wasmannia auropunctata (Roger), Figs. 19-26.—19, head of worker larva in anterior view, ×148; 20, right antenna of queen larva in anterior view, ×680; 21, right galea of queen larva in lateral view, ×680; 22, left mandible of worker larva in anterior view, ×340; 23, profile of worker larva, ×10; 24, profile of queen larva, ×10; 25, body hair of worker larva, ×185; 26, worker larva in side view, ×56.

each half of the ventral border with one isolated and two contiguous sensilla; posterior surface of each half with a cluster of three contiguous sensilla.

Young larva.—Length about 0.68 mm. Head wider than the prothorax, diameter decreasing to abdominal somite I, increasing to V and decreasing to the posterior end which is sharp-pointed. Body hairs of two types: (1) simple, minute to short (0.006-0.018 mm), on ventral and lateral surfaces of the thorax and abdominal somites I-VIII; (2) short (0.018-0.045 mm), with denticulate tip, on the dorsal surface of the thorax and abdominal somites I-V; abdominal somites IX and X naked. A few minute spinules on the dorsal surface of abdominal somites V-X. Head hairs simple and slender, 0.012-0.027 mm long. Maxillary palp a slightly raised cluster of four sensilla; galea a low knob with two sensilla. (*Material studied*: a dozen larvae from Queensland, courtesy of Dr. W. L. Brown.)

TETRAMORIUM STRIATIVENTRE Mayr

Immature (?) larva.—Length about 2.3 mm. Generally similar to *caespitum* but differing in the following details: Body hairs of three types: (1) short (0.036-0.081 mm), bifid-tipped, with the branches denticulate, the most abundant type; (2) few, moderately long (0.1-0.14 mm), bifid-tipped, with the branches denticulate; (3) anchor-tipped, with tortuous shaft, long (about 0.32 mm), four in a row across the dorsum of each abdominal somite I-IV. Head hairs bifid-tipped, with the branches denticulate, 0.027-0.072 mm long. Labrum with the anterior surface bearing three hairs and one or two sensilla; ventral border of each lobe with one isolated and two contiguous sensilla; posterior surface of each lobe with one or two isolated and a cluster of two or three sensilla. Mandibular teeth longer and sharper-pointed. Maxillary palp a tall frustum bearing five sensilla (four apical and one lateral).

Young larva.—Length about 1.3 mm. (Ready to molt.) Slender, thorax slightly curved ventrally; ventral profile of abdomen nearly straight. Body hairs very few. Of three types: (1) minute to short (0.001-0.018 mm), simple, on the entire ventral surface and on the dorsal surface of abdominal somites VI-X; (2) long (0.027-0.072 mm), on the dorsal and lateral surfaces and one at either end of each row of anchor-tipped hairs, simple or with bifid tip; (3) anchor-tipped, long (0.054-0.105 mm), with sinuous shaft, 2-4 in row across the dorsum of each abdominal somite I-V. Head hairs with short-bifid tip, 0.018-0.036 mm long. Antennae minute. Mandibles with short acuminate teeth. Maxillary palp a cluster of five sensilla; galea a short knob with two apical sensilla. (*Material studied*: 13 integuments from Turkestan.)

Genus STRONGYLOGNATHUS Mayr

STRONGYLOGNATHUS TESTACEUS (Schenck)

Wheeler (1910, p. 491) stated that the workers of this social parasite took no interest in their own brood, which was tended by the host workers (*Tetramorium caespitum*).

Genus XIPHOMYRMEX Forel

Body hairs of two types: (1) short to moderately long, with long flexible tip; (2) long, anchor-tipped. Head hairs few, moderately long, with the tip simple, bifid or denticulate. Antennae minute. Labrum feebly bilobed; posterior surface densely spinulose. Mandibles divided into two portions, basal two-thirds subtriangular in anterior view, with a stout double-pointed distal tooth projecting ventromedially; apical third very slender, curved medially, with the apex narrowly round-pointed and bearing on its inner surface a small acute tooth. Maxillae bearing a few minute spinules; apex paraboloidal. Labium with the anterior surface spinulose; palps lateral, each represented by a slight elevation bearing sensilla; an isolated sensillum between each palp and the opening of the sericteries. Hypopharynx densely spinulose, the spinules rather long and arranged in short rows dorsally; ventrally the spinules are shorter and the rows longer.

XIPHOMYRMEX TURNERI Forel

Pl. I, figs. 12-15

Immature larva.—(Ready to molt.) Leg vestiges present. Spiracles small; the mesothoracic the largest; size diminishing posteriorly. Integument of ventral surface of anterior somites and dorsal surface of posterior somites with minute spinules in short transverse

rows. Body hairs of two types: (1) short to moderately long (0.036-0.108 mm), with denticulate tip; (2) anchor-tipped, about 0.18 mm long. Cranium subquadrate in anterior view, with all corners rounded. Head hairs few, moderately long (0.036-0.072 mm), with the tip simple or bifid or denticulate. Antennae minute, elevated, each with three sensilla, each of which bears a spinule. Labrum subrectangular, slightly narrowed dorsally, breadth about $1.7 \times$ the length; feebly bilobed; anterior surface of each lobe with one short and three minute hairs and one sensillum; ventral border of each lobe with numerous spinules, one or two isolated sensilla and two contiguous sensilla; posterior surface of each lobe with two isolated and two contiguous sensilla; posterior surface spinulose, the spinules minute and in short rows. Mandibles divided into two portions: basal two-thirds subtriangular in anterior view with a stout double-pointed distal tooth projecting ventromedially; apical third very slender, curved medially, with the apex narrowly round-pointed and bearing on its inner surface a small acute tooth. Maxillae with the apex paraboloidal and bearing a few spinules; palp a skewed peg bearing five sensilla; galea a tall frustum bearing two apical sensilla. Labium with the anterior surface spinulose, the spinules minute and in short transverse rows; palp a slight elevation bearing sensilla; an isolated sensillum between each palp and the opening of the sceriteries; the latter a short transverse slit. Hypopharynx densely spinulose, the spinules relatively long and arranged in short rows dorsally; ventrally the spinules are shorter and the rows longer.

Next instar larva.—Body hairs of two types: (1) short to moderately long (0.036-0.29 mm), with denticulate tip; (2) anchor-tipped, long (about 0.32 mm), with tortuous shaft. (*Material studied:* parts of two damaged integuments from New South Wales.)

Genus TRIGLYPHOTHRIX Forel

TRIGLYPHOTHRIX AREOLATUS Stitz

Eidmann, 1944, p. 456: "Die Larven haben einen dichten Besatz von ankerförmigen Oenochäten, besonders auf der Rückseite des Abdomens, wo diese besonders gross und korkzieherartig gekrümmt sind und dadurch elastisch federnd wirken."

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Drosophilidae in New York and New Jersey

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Flies of the family Drosophilidae are useful for the study of evolution from many aspects. Thus, citations to work with these species on problems of mutation, selection, population structure, isolating mechanisms, among others, may be found in the summary of the field by Dobzhansky (1951). An aspect of the problem that has recently received greater attention, that of correlated studies of taxonomy, ecology, and population genetics, has been largely neglected with respect to the members of this family inhabiting the eastern United States, particularly the region east of the Appalachians. In a pioneering work, Sturtevant (1921) collected the records of the family from the literature of systematic entomology and described the distribution of the species then known. The emphasis was on the eastern species, but since then the number of known species has greatly increased. The extensive collections of Patterson (1943) reached Ohio and some of the southeastern states. In the same publication Patterson and Wagner show up-to-date distribution maps for many eastern species, but their conclusions concerning the species characteristic of the "Entire East" or of the "Northeast" do not appear justified in view of the scarcity of modern data from the area outside of Ohio. Spiess (1949) described collections at several points in New England. The present paper, the first in a series by the author concerning Drosophilidae of the eastern states, records collections from a number of localities in New York and New Jersey. The data extend the known distributions of several species; they reveal seasonal fluctuations in numbers of several species; and they show differences in the sex ratios are obtained for the various species.

Acknowledgements.—The author is grateful to Dr. Bruce Wallace and Mr. Michael Svetina, Jr., for aid in the collections; to Dr. G. E. Matzke for suggesting the site of the Englewood Cliffs study and describing the vegetation; and to Professor Th. Dobzhansky, Drs. E. B. Spiess, W. P. Spencer, J. T. Patterson, and Marshall R. Wheeler, who checked some of the identifications. Also, Professors Dobzhansky, H. S. Stalker and H. L. Carson were kind enough to read and criticize the manuscript.

Sites of the collections.—In the summer of 1947 collections were made by the author in southeastern New York and northern New Jersey, as follows: New York: East of Baldwin and in Massapequa State Park, Nassau County; Van Cortland Park, Bronx County; Pelham Bay Park, Bronx County; near Huguenot, Orange County; Tibbetts Brook Park near Dunwoodie Station, Yonkers, Westchester County; Mariner's Harbor, Staten Island, Richmond County. New Jersey: Palisades area east of the town of Fort Lee, Bergen County; High Point State Park, Sussex County; west of Fort Lee, near U.S. Route 4, Bergen County. Also collections were made by Dr. H. H. Swift near Rhinebeck, Dutchess County, New York. In 1948 and 1949 collections were made at a single site near Englewood Cliffs, Bergen County, New Jersey.

According to Braun (1950) all the collection sites lie in the Wisconsinian glaciated portion of the oak-chestnut region of the eastern United States. At the time of these collections chestnuts were rare, and at most of the collection sites maple, birch, and young beech trees were more common than oak. Thus, at Englewood Cliffs, the higher ground near the entrance to the woods is mostly

populated with various types of oak; but at the lower, wetter area where the traps were placed, beech, cherry birch, basswood, red maple, and sour gum are predominant. Dogwood, blue beech (*Carpinus*) and witch hazel form a second tier, and high bush blueberries and Azaleas are common shrubs. Also present is considerable bog moss (*Sphagnum*), Jack-in-the-pulpit, and false hellebore (*Veratrum viride*).

Collections within the boundaries of public parks were far from the points usually visited by picnickers. Only the Mariner's Harbor and Rhinebeck sites were quite close to human habitations.

Methods.—Mashed bananas were used as bait in all the collections, though mashed melon and peaches were also used at one place in 1947. In the early collections Fleischman's yeast was previously added to the mash and the fermented bait placed on the ground in paper cups on each visit to the collecting site. After August, 1947, the bait was allowed to remain continuously in the field. Addition of yeast was thereupon discontinued in order to prolong the "life" of the bait. Also, Mason jars were substituted for paper cups to minimize depredation from dogs and rodents. At Englewood Cliffs the traps were maintained in approximately constant positions by fastening them to trees with wire. The flies were generally identified under light etherization in the laboratory, but most of the 1947 collections were pinned for later identification. Identifications were based on the keys and descriptions of Sturtevant (1921, 1942) and Patterson (1943).

Results.—Table 1 lists the species identified in the collections. Since some of the pinned specimens were accidentally lost, the data may be incomplete. The *D. melanica* were members of the subspecies *paramelanica* Patterson, 1943. In the Englewood Cliffs material this species showed considerable variation in appearance; Professor W. P. Spencer, who was kind enough to check the author's identifications, confirmed that the specimens belonged to the subspecies *paramelanica* but noted that the males in particular had darker and more distinct abdominal banding than the members of this subspecies living in Ohio (private communication). Whenever closer examination was made the *D. athabasca* and the *D. affinis* proved to be of the subspecies *mahican* and *iroquois* (Sturtevant and Dobzhansky 1936), respectively.

Table 2 records the species obtained in repeated collections in Englewood Cliffs, New Jersey. In 1948 a severe winter and late spring delayed the emergence of *Drosophila* until early May. The next year collections were possible much earlier. The 1949 data is therefore divided into two periods, March 28-April 27 and May 4-June 8; for many species the spring, 1948 data resemble the early spring period of 1949 more than the later one. To evaluate possible fluctuations in the data, it is presented in two ways: 1) The number collected of each species or complex is given as a percentage of the total flies collected in the period, the figures adding up to 100% in each column. 2) For each of the more common species, the number obtained in a period was divided by the number of collections, giving the average collection per trip; each period's average collection is shown in the table as a percentage of the sum of the average collections of that species for the four periods of the study, the figures totalling 100% in each row. The second-named method was used by Patterson (1943) and Spiess (1949) to show seasonal fluctuations in their data, but when used alone it ignores factors making for abundance or rarity of all flies and differ-

ences in the amount of time spent in the field per trip at different seasons. Also, by analyzing each species or group separately, the method loses sight of possible competition between species.

The identifications were speeded by not differentiating between the females of the *affinis* group species. Likewise, separate counts were not made of *D. athabasca* and *D. narragansett*. It was noted, however, that the former was far the more common of the two; in fact, *D. athabasca* seemed to be the most common species in these woods in every season. *D. simulans* and *D. melanogaster* were also not differentiated in the counts.

The collections indicate that the species have their peak frequencies at different seasons. With the possible exception of *D. affinis* at Englewood Cliffs, the largest collections of the *affinis* group occurred in the spring and early summer. Even in the earliest spring collections, when their average number collected was smallest, these species constituted a larger share of the total collection than they did in the fall. *C. amoena* was also more common in the spring; in 1947 it did not appear in any collection after July 26th. The melanicas, *D. robusta*, *D. transversa*, *D. putrida*, *D. immigrans*, and the melanogaster-simulans complex were most common in the August and September collections. Possibly because of the milder weather, two native species which have a late summer peak, namely *D. robusta* and *D. melanica*, were clearly more common in the earliest 1949 collections than in the corresponding 1948 data. The two native "fungus feeders" among the warm-loving species, *D. transversa* and *D. putrida*, do not show this relationship. The fall in the collections of *D. robusta* and *D. melanica* in the late spring data in 1949 is probably due to demise of the over-wintering generation, the collections occurring prior to the mass hatching of the first new generation. Since *D. robusta* was simultaneously being studied with respect to its chromosomal polymorphism (Levitan 1951), it was particularly noted that the species became common again near the end of the late spring collections and the specimens taken then included young-appearing flies for the first time. The absence of a fall in the frequencies of the *affinis* group in the late spring is probably related to the quicker development of these species.

In every collecting period a significantly larger number of males were obtained than females. This reflects mainly the large excess of males in the *affinis* group. If the data for this group are deducted, the majority of the males remains highly significant only in the fall data. *D. immigrans*, *D. putrida*, and *D. testacea* also show highly significant excesses of males. For most other species the sex ratios are not significantly aberrant. However, significantly more females than males were obtained of *D. melanica*.

Discussion.—This paper records *D. testacea*, *D. narragansett*, and *D. nigro-melanica* for the first time from both New York and New Jersey. Also, *D. athabasca* had not previously been reported from New York, and *D. robusta*, *D. melanica*, and *D. duncani* are newly recorded for New Jersey. Since most of these species have previously been reported in both Ohio (Patterson 1943) and New England (Spiess 1949), their discovery here is hardly unexpected. However, the finding of *D. duncani* in New Jersey extends considerably the known distribution of that species. *D. duncani* mainly inhabits the south and west-central states, and the nearest previous collection of it was in extreme western New York (unpublished 1941, Rochester, N. Y., data of Dr. H. S.

Stalker, quoted with his kind permission). The two males collected in New Jersey were fully fertile with a standard strain of the species (Patterson, private communication).

The collections contained twenty-one species of Drosophilidae. The twenty species of the genus *Drosophila* represent four subgenera, *Sophophora*, *Drosophila*, *Hirtodrosophila*, and *Dorsilopha*. Thirteen of the species are probably native to the Nearctic, seven probably introduced and associated here with the habitats of man (Patterson and Wagner 1943). Four native species previously reported from New York (*D. colorata*, *D. melanura*, *D. palustris*, and *D. sigmoides*) and two from New Jersey (*D. palustris* and *D. guttifera*) were not obtained. Also, *D. duncani* was not obtained in New York. The data increase to seventeen the number of native species of the genus *Drosophila* known from New York, and to fifteen the number from New Jersey. *D. colorata* and *D. sigmoides* are found in states south of New Jersey and *D. guttifera* is also found in Massachusetts (Sturtevant 1921); similarly, *D. melanura* has recently been found south of New Jersey (Leviton, unpublished). Therefore, the number of native species in New York and New Jersey is more likely eighteen. These numbers compare with the nine known from Vermont (Spiess 1949) and the even smaller numbers reported from Idaho and South Dakota (Patterson 1943). Patterson reports twenty-one native species in Ohio, twenty-two in Tennessee, and thirty-eight in Texas. Similarly, southern Nebraska appears to have between sixteen and twenty-one native species (Williams and Miller 1952). While not all the areas mentioned have been equally well studied, the data from New York and northern New Jersey seem to fit the inverse relation of numbers of species to latitude that has been noted for several groups.

Dobzhansky (1950) suggests that the diminution in species diversity from south to north in North America results from a contraction of the number of available ecological niches and, further, that the number of different habitats the species can exploit depends on its ability to develop adaptive polymorphism. The good correlation between the chromosomal polymorphism and distribution of a number of species of *Drosophila* in Brazil and western North America seems to support this hypothesis (Dobzhansky *et al.* 1950). The eastern United States are much more uniform, in a macroecological sense at least, than Brazil and the western states. Here Dobzhansky's hypothesis implies that variations in species distribution depends primarily on the variety of microecological conditions available. It therefore calls for further study of the microhabitats of *Drosophila* species.

The meaning of the differences in sex ratio noted in the text is not clear. Spencer (1942) obtained a disparate sex ratio for *D. quinaria* on banana bait but not on tomato or potato plants. Similarly, daCunha *et al.* (1951) state that they obtained many more males than females of the *obscura-affinis* group with various yeast baits but an almost equal number of the two sexes on banana. Although their data is not completely convincing in this respect (the writer has calculated that $57.53 \pm 1.27\%$ males were obtained with banana bait in the second of their two experiments), daCunha *et al.* did obtain large differences in the degree of preponderance of males in the flies attracted by the different yeasts. Carson and Stalker (1951) noted that samples of several species which show an excess of males in banana trap collections consist mostly

of females when taken on certain slime fluxes. From these observations it seems doubtful that an aberrant sex ratio (or even a normal one) in a collection reflects a similar condition in the natural population. Rather, the data suggests that the two sexes may differ in their feeding habits or in the degree to which they are attracted to certain materials. If they differ in their feeding habits, this may be an additional form of adaptive polymorphism. Natural selection might then be expected to have a different effect on the two sexes under circumstances which affect the food preferred by one sex but not the other.

Summary.—Collections of Drosophilidae were made in deciduous woods in northern New Jersey and southeastern New York. The more than 8,000 flies captured belonged to twenty-one species, twenty of the genus *Drosophila* and one *Chymomyza*. The data increases the number of native species of *Drosophila* known in New Jersey to fifteen, and to sixteen the number in New York. The number of native species in this region fits the rule of diminution of species from Equator to Pole.

The affinis group of four species were the commonest *Drosophila* in every season, but they constituted a larger share of the catch in the spring than in the fall. Most other species were commoner in the fall than in the spring.

Significantly more males than females were collected of several species, while the sample of one species contained a significant excess of females. It is not clear whether the populations of these species have such disparate sex ratios or whether the data reflect differences in feeding habits or attraction to baits of the two sexes.

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TABLE 1.—Species of Drosophilidae collected in southern New York (1947) and northern New Jersey (1947-1949)

NATIVE SPECIES

1. *Chymomyza amoena* Loew, 1862
2. *Drosophila affinis* Sturtevant, 1916
3. *D. algonquin* Sturtevant and Dobzhansky, 1936
4. *D. athabasca* Sturtevant and Dobzhansky, 1936
5. *D. duncani* Sturtevant, 1918*, **
6. *D. melanica* Sturtevant, 1916
7. *D. narragansett* Sturtevant and Dobzhansky, 1936
8. *D. nigromelanica* Patterson and Wheeler, 1942
9. *D. putrida* Sturtevant, 1916
10. *D. quinaria* Loew, 1865**
11. *D. robusta* Sturtevant, 1916
12. *D. testacea* van Roser, 1840
13. *D. transversa* Fallen, 1830
14. *D. tripunctata* Loew, 1862

COSMOPOLITAN SPECIES

1. *D. busckii* Coquillett, 1901**
2. *D. funebris* Fabricius, 1787**
3. *D. hydei* Sturtevant, 1921**
4. *D. immigrans* Sturtevant, 1921
5. *D. melanogaster* Meigen, 1830
6. *D. repleta* Wollaston, 1858**
7. *D. simulans* Sturtevant, 1919

* Not collected by the author in New York.

** Rare (i.e., never more than five specimens per trip) in these collections; the cosmopolitan species listed are probably very common in urban areas of these states.

TABLE 2.—Collections of Drosophilidae near Englewood Cliffs, New Jersey, in 1948 and 1949

	Percent of Flies Collected				Percent of the Total Average Collections of each Species				Percent Males (in totals)
	May 6- Jun. 14 1948	Aug. 24- Oct. 4 1948	Mar. 28- Apr. 27 1949	May 4- Jun. 8 1949	May 6- Jun. 14 1948	Aug. 24- Oct. 4 1948	Mar. 28- Apr. 27 1949	May 4- Jun. 8 1949	
Affinis group	73.93	61.32	79.62	91.89	11.7	29.5	11.5	47.3	73.56 ± 0.68†
<i>D. affinis</i>	7.73	5.44	0.15	0.57	29.4	53.4	0.5	7.1
<i>D. algonquin</i>	4.17	1.78	7.05	3.73	14.8	19.2	22.9	43.1
<i>D. athabasca</i> & <i>D. narragansett</i>	47.04	38.83	46.93	57.65	11.9	29.8	10.9	47.4
Group females	14.99	15.27	25.49	29.94	8.2	25.5	12.8	53.5
<i>D. robusta</i>	1.50	7.26	11.84	1.71	3.7	55.2	27.2	13.9	53.68 ± 2.61
<i>D. melanica</i>	1.09	4.54	2.85	0.19	6.0	76.2	14.4	3.4	30.85 ± 3.65
<i>D. nigromelanica</i>	0.36	1.91	0.15	0.13	5.4	86.5	2.0	6.1	44.29 ± 5.98
<i>D. transversa</i>	9.02	5.60	2.40	1.96	26.0	49.2	6.4	18.5	47.40 ± 2.50
<i>D. purpurina</i>	8.09	6.92	3.00	2.98	19.5	50.6	6.6	23.3	67.87 ± 2.37
<i>D. testacea</i>	1.75	0.69	0.00	0.44	33.2	39.5	0.0	27.3	80.97 ± 6.30
<i>C. amoena</i>	3.50	0.0	0.15	0.19	82.3	0.0	3.2	14.5	58.33 ± 5.89
<i>D. melanogaster</i> & <i>D. simulans</i>	0.36	4.76	0.0	0.32	1.2	93.7	0.0	4.0	45.06 ± 3.97
<i>D. immigrans</i>	0.26	6.88	0.0	0.19	2.3	94.2	0.0	4.6	77.39 ± 3.30
Total	1940*	3196**	667	1580	12.2	37.0	11.2	39.6	68.82 ± 0.58
Number of collections	24	13	9	6					

* Includes also 1 *D. quinaria* female and 1 *D. busckii* male.** Includes also 1 *D. tripunctata* female, 2 *D. duncani* males and 1 *D. funebris* male.

† Standard error testing deviation from equality of the two sexes.

Haemopsis kingi, New Species (Annelida, Hirudinea)

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While collecting specimens for the writing of *The Leeches of the Okoboji Region*, Iowa Lakeside Laboratory, Lake Okoboji, Iowa, 1946 and 1947, a new species of leech belonging to the genus *Haemopsis* was discovered. Morphological and anatomical features of the leech show it to be distinct from other species of *Haemopsis*, *H. marmoratis* Say, *H. lateralis* Say, *H. plumbeus* Moore and *H. grandis* Verrill, our American representatives, and *H. sanguisuga*, a closely related European species. The new animal has been named *Haemopsis kingi*.*

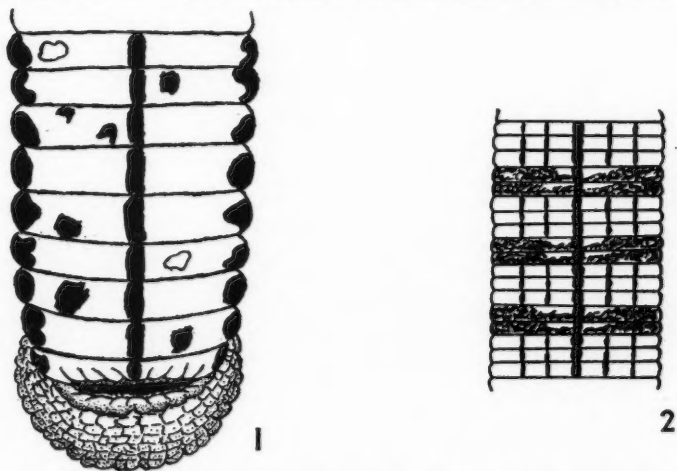
Diagnosis.—Size medium, never large (mature specimens, well extended, about 60 x 8 to 90 x 12 mm; living, fully extended, about 90 x 5 to 130 x 8 mm); elongate, slender, general body form similar to other *Haemopsis*, but with region posterior to clitellum equidistant in width; caudal sucker conspicuously large, nearly or as wide as body; jaws tri-radiate, small, semi-globular and with 9 to 14 distichodont type teeth with lobed bases imbedded in a basal membrane which is held in position by membranous plugs which fit into pits in grooves which run over the free surface of the jaws; ejaculatory bulbs very small, short, fusiform, slightly crescentic; atrium slender, rather short, U-shaped; right ejaculatory bulb and epididymis usually displaced one somite anterior to left (the right in XII, left in XIII); vaginal bulb small, pyriform, bent or curved and of two distinct regions: ental portion dome-shaped, rigid, curved or bent, distal portion globular, flaccid. Dorsal ground color uniform brownish-green or olive with typical markings of a series of black, median blotches which form a continuous, longitudinal stripe, and scattered black and yellowish-orange blotches; margins conspicuously mottled with yellowish-orange blotches forming broken longitudinal lines; ventrally darker, plumbeous and uniform except for occasional yellowish-orange blotches.

Description of type.—Form elongate, slender. Cephalic end gradually attenuated, terete from clitellum anterior to the head region, which is slightly widened and flattened. Except for the last 2 or 3 annuli which attenuate rather abruptly the body region from the clitellum posterior is equidistant in width, rounded dorsally and somewhat flattened ventrally (when the leech is swimming this region is much flattened, the margins becoming thin and flangelike). This is the widest region of the body except during mating time, then the posterior clitellar region may become obviously wider. The body is rather muscular, quite firm. Measurements, well extended, in mm: length 78, to male pore 18; widths, buccal 3, at male pore 8, maximum (nearly same from somites XI through XXV) 9, anus 4 (living leech, fully extended, about 110 x 6); depths at same points 1, 3, 2.5, 1.5. Head relatively large, rounded. Mouth large, circular. Lips broad and thick, with distinct lateral lobes; dorsally areolated, of lighter pigmentation and with numerous sensory papillae; ventrally areolated, with 6 or 7 longitudinal furrows which extend back into the mouth and with numerous sensory papillae which continue back along the margins of somite V, thence as two rows across the buccal ring. Buccal ring with moderate lateral lobes. Eyes 5 pairs, pigment cups large. Pairs 1 and 2 on caudal edges of somites II and III, largest, very conspicuous, directed cephalo-laterad and tilted slightly dorsal; pair 3 on caudal edge of IV a1 and pair 4 on caudal half of V a1, about one-half size of 1 and 2, somewhat deeper but conspicuous, directed latero-caudal and tilted slightly dorsal; pair 5 on middle of VI a2, about same size as 3 and 4, most deeply imbedded, hence somewhat inconspicuous, directed caudal, and tilted slightly dorsal. Inequality of annulation begins with somite VI as discussed under annulation. Clitellum distinct, thickened, firm and extending over 15 annuli (X b5 through XIII a2). Gonopores separated by 5 annuli; male in anterior 1/3 of XI b6, an obvious, puckered transverse slit including a rounded pore which be-

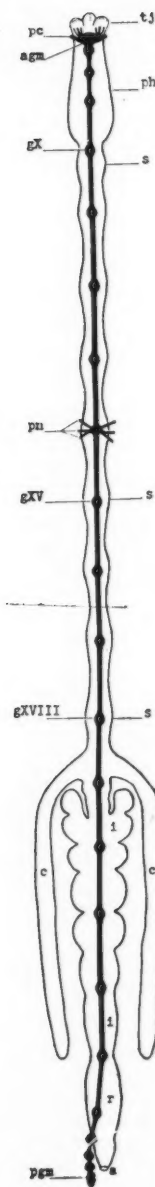
* For aid and direction during the course of the present investigation, I take pleasure in acknowledging my indebtedness to the man for whom the new species is named, Dr. R. L. King (Professor of Zoology at the State University of Iowa). Appreciation is also expressed to Dr. J. Percy Moore.

comes elliptical to circular with the protrusion of the penis; female a similar opening in extreme anterior edge of XII b6. Nephropores distinct, papillate, the usual 17 pairs and in the usual position in the intermediate line and caudal margin of the venter of b6 of VIII through XXIV. The metameric sensillae likewise have the usual position. Anus very large, about $1/3$ width of posterior body, opening on caudal border of XXVII above the short sucker pedicel. Caudal sucker (fig. 1) very large, nearly or as wide as body, discoid and broadly attached by a short posterior pedicel which tapers to direct attachment to XXVII anteriorly; only $1/4$ of it projects beyond the body posteriorly and its anterior border reaches to XXIV a2; dorsal face with 5 or 6 rows of areolae with small sensory papillae; ventral face finely tessellated and with numerous fine radiating ridges; margins crenulate. *Coloration* (fig. 1) distinct, especially in living specimens. Dorsally, ground color a uniform brownish-green to olive with typical markings of a series of black, median blotches which form a continuous, longitudinal stripe, and scattered black and yellowish-orange blotches (usually more black than yellowish-orange); margins conspicuously mottled with yellowish-orange blotches forming broken longitudinal lines; ventrally darker, plumbeous and uniform except for occasional yellowish-orange blotches. *Coloration of young* (fig. 2): the early coloration is pink to reddish, uniform dorsally and ventrally or somewhat lighter ventrally, nearly transparent. After about three weeks the color becomes somewhat checker-board in pattern. The dorsal ground color is light olive with a median, longitudinal green stripe, paired lateral longitudinal grayish-green to light brown lines and wide grayish-green to light brown metameric transverse markings or broad stripes which occupy two annuli (b6 and b1 of two successive somites). The yellowish-orange marginal blotches appear several weeks later as the dorsal checker-board pattern blends into a nearly uniform brownish-green or olive ground color with a few scattered black and yellowish-orange blotches. The median, longitudinal stripe also becomes its characteristic black color.

Annulation.—Except on the head the annulation is very distinct. Prostomium a rounded lobe with longitudinal and transverse furrows ventrally and bearing dorsally numerous small sensory papillae. Prostomium and I, the preocular lobe, indistinguishable,



Figs. 1, 2.—1. Dorsal view of posterior region showing very large caudal sucker and anus, equidistant width of body and dorsal color markings: median, longitudinal stripe (black), marginal blotches forming longitudinal lines (yellowish-orange) and diffuse blotches (black and yellowish-orange), about $4\times$; 2. Dorsal view of two complete somites and adjacent annuli of young leech (about 2-3 weeks old) showing somewhat checkerboard color pattern: a median, longitudinal stripe (green), paired lateral, longitudinal lines (grayish-green to light brown) and wide metameric transverse markings or stripes (grayish-green to light brown) which occupy two annuli (b6 and b1 of successive somites), about $8\times$.



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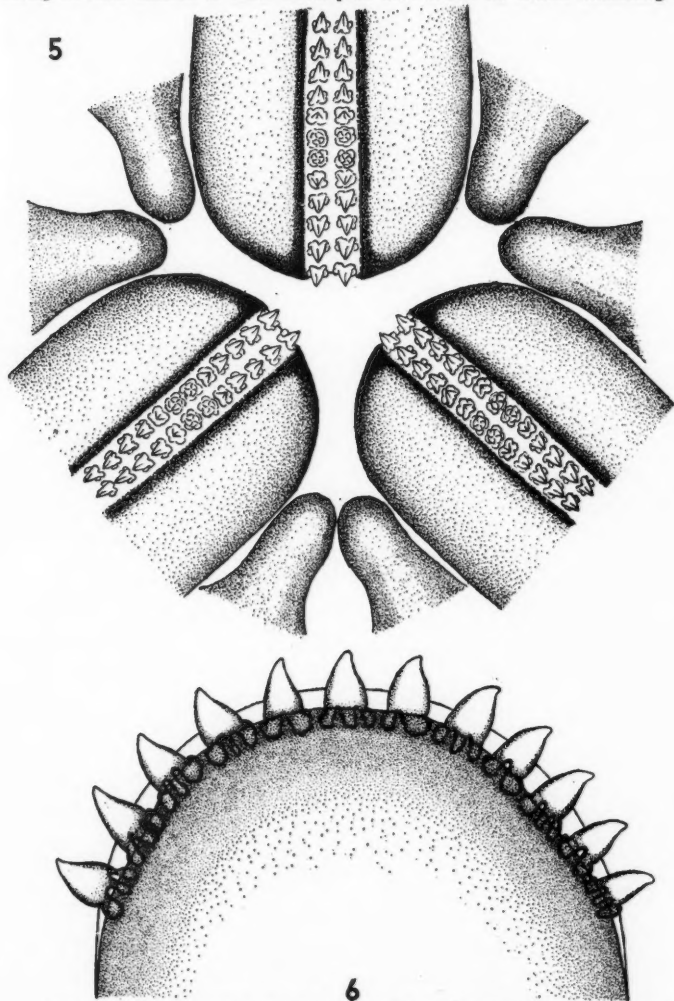
composed of areolae united at the margins. Somite I can seldom be distinguished from II (uniannulate) which is distinguishable from III by only a mid-dorsal furrow. The latter two somites bear the 1st and 2nd pairs of eyes. III (uniannulate) and IV are divided fully to the margins. IV biannulate, its interannular furrow clearly defined only dorsally, the annuli running together at their margins. IV a1 bears the 3rd pair of eyes. II, III, and IV exhibit numerous areolae. IV and V are well divided. The annuli of V (biannulate) are well elaborated dorsally but unite ventrally to form the buccal ring. V a1 bears the 4th pair of eyes. VI triannulate, a1 and a2 fully separated by a furrow confined to dorsal region, a3 wider and may exhibit an incipient furrow. VI a2 bears the 5th pair of eyes. VII fully triannulate, a3 wide and with dorsal cross furrow. VIII quadriannulate, a1 as in a3 VII, wide and with a more distinct cross furrow. IX through XXIII are quinquianulate (15 complete, 5-annulate somites), all approximately equal. XXIV quadriannulate, last (a3) wider. XXV triannulate, a1 wider. XXVI and XXVII (uniannulate) fuse together ventrally above the sucker. XXVII has marginal furrows. The annulation in the young is the same as in the adult.

Anatomy.—As determined from dissection of 6 paratype specimens. The nervous system (fig. 3), which has been previously described several times within the genus, is in agreement, showing no unique features (its structure and situation are sufficiently indicated as superimposed on the figure of the alimentary system).

Jaws and teeth.—(figs. 5, 6) Jaws triradial, terminating in the pharynx, far back in VII, semi-globular and retractile into sinuses in the wall of the circumpharyngeal chamber. Teeth 9 to 14 pairs on each jaw, distichodont type, coarse, hyaline, conical, slightly retrorse, with lobed bases, imbedded in or attached to a basal membrane which is held in position by membranous plugs, one plug under each pair of teeth (fig. 7). These plugs fit into pits in grooves which run over the free surface of the jaws (in recently killed specimens the teeth and surrounding membrane projecting plugs are easily pulled away from the jaws exposing the grooves of the jaws and pits in which the teeth and plugs are set. This is also true for *H. marmoratus* and *H. lateralis*). The jaws and teeth in a miniature are present in the newly hatched young.

Figs. 3, 4.—3, Ventral view of alimentary system and ventral nerve cord with ganglia, about 2×; t.j, triradial jaws with teeth; ph, pharynx; s, stomach or crop; c, caecum; i, intestine; r, rectum; a, anus; pc, pharyngeal collar or circumpharyngeal connective; agm, subpharyngeal mass of anterior ganglionic mass; gX, gXV, gXVIII, ganglia X, XV, XVIII; pn, peripheral nerves arising from ganglion XIV (the other ganglia possess similar nerves but have been omitted); pgm, posterior ganglionic mass; 4, Alimentary system of young (about 2 or 3 weeks old) showing the paired extensive gastric caeca along the entire length of the crop of stomach, about 2×.

Alimentary system.—(fig. 3) Pharynx rather long, vase-shaped, extending to about the middle of X, internally thrown into 9 to 12 or 15 longitudinal folds, the posterior having the latter numbers of which certain pairs unite toward the anterior terminating the



Figs. 5, 6.—5. Jaws and teeth, anterior view, about 36 \times . Triradiate jaws each with 9-14 pairs of distichodont, conical, lobed-based teeth set in a median groove. Between the jaws are the paired, longitudinal folds of the anterior pharynx; 6. Details of a single jaw, lateral view, 72 \times . Semi-globular jaw with conical, lobed-based teeth possessing acute, hyaline, retrorse tips set in the median groove. From lateral view only one of the double series of teeth is observable.

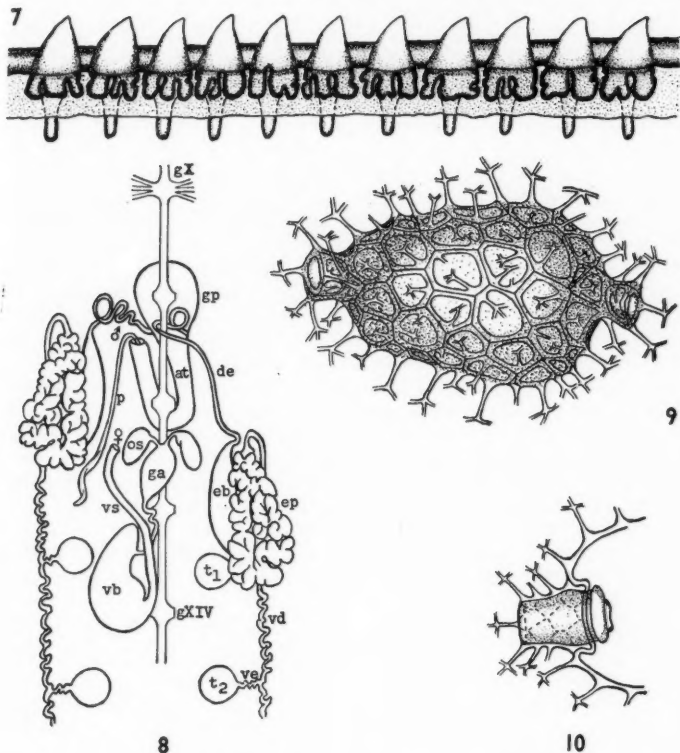
jaws, the others, usually 6, in pairs occupy the spaces between. A short nearly indistinguishable esophagus occupies the middle of X. Crop or stomach is a straight tube with slight globular enlargements in X through XVIII. From the posterior of the crop, in XIX, there arises a lengthy pair of nearly straight, cylindrical, parallel gastric caeca which extend to XXIII. The much enlarged, segmentally arranged, globular-pouched intestine, extending from XIX through XXIII terminates with a much shorter, thin-walled rectum which begins in XXIII and opens dorsally by way of the very large anus in XXVII. The globular enlargements, posterior gastric caeca, intestine and rectum become much enlarged when filled with food. Internally, the crop, caeca and intestine possess several longitudinal folds and numerous smaller complexes of wrinkles and folds. *Alimentary system of young* (fig. 4): as probably in all young *Haemopsis* there are paired gastric caeca along the entire extent of the crop; from X to XVIII inclusive, each somite possesses two pairs of lateral gastric caeca, of which those from XIII posteriorly are of larger size. The last pair, the parallel pair, as in the adult, originate from the crop in the latter part of XIX, are very extensive, reaching backwards into XXIII.

Male reproductive organs.—(fig. 8) Include the usual 10 pairs of testisacs intersegmentally located from XIII and XIV through XXII and XXIII, with associated vasa efferentia and vasa deferentia. In XI the vasa deferentia pass into the anterior end of the epididymes (spermatic vesicles), moderately large, compactly coiled tubes situated intimately, ventrally and with their largest mass lying at the posterior end of the very small, short, fusiform, somewhat crescentic ejaculatory bulbs. The ejaculatory bulb and epididymis on one side are constantly displaced one somite anterior to the other, most commonly, the right being anteriormost in XII, lateral to the atrium and those on the left in XIII. At the anterior end of each ejaculatory bulb arises the ductus ejaculatorius, the longer, on the left, being straight except for its anterior end which loops ventro-dorsally around the nerve cord and passes into the comparatively large prostate gland in XI, the shorter, on the right, being usually much looped passing beneath the nerve cord. The slender, rather short U-shaped atrium, both limbs nearly straight or slightly twisted and of same length, is located in XI and XII from which, during copulation, is protruded the moderately long filamentous penis (protruded 2 times body width). It is slender and straight except for its twisted or slightly corkscrew-like terminal tip. The *female reproductive organs* (fig. 8) consist of the paired ovoid or pear-shaped ovisacs in the last part of XII and the first part of XIII. Leading from each ovisac and passing into the anterior of the elongated, somewhat obovoid, median albumen gland in XIII is a short right and left oviduct. The common oviduct, a somewhat larger coiled tube, arises from the posterior end of the albumen gland, passes dorsally under the vaginal stalk and enters at a right angle one-half way down the distal dome-shaped portion of the vaginal bulb. The vaginal bulb in XIV is small, pyriform, curved or bent and of two distinct regions, the ental portion dome-shaped, rigid, and curved or bent at about a 45° angle from the distal globular flaccid portion. Continuing from the distal portion of the vaginal bulb is the slender, rather short, slightly bent or twisted vaginal stalk which passes through part of XIV, all of XIII and opens by way of the female gonopore on XII b6.

Notes on paratypes.—Four well extended specimens, all mature and with thickened clitellums, measure in mm from 63 x 8 to 90 x 11 (in life when fully extended, about 100 x 6 to 125 x 7). The caudal suckers are very large as in the type, but in the larger two are slightly narrower than the body. The annulation is in agreement with the type except that in one paratype VI a1/a2 is furrowed only on the left half of the dorsum. In all, the jaws and teeth and whole alimentary canal are in agreement with the type. The reproductive organs are also in agreement with the type except that in one specimen the distal portion of the vaginal bulb is not enlarged, hence is more clavate than pyriform. The coloration is constant in all.

Type specimens.—Holotype and 3 representative paratypes will be deposited in the U.S. National Museum. Other paratypes are in the writer's collection.

Ecology.—At present, the only locality in which the new species has been found or reported is Silver Lake Fen, the springy area along the southwest shore of Silver Lake, Lake Park, Iowa. Silver Lake Fen drains into this corner of the lake, which is a shallow body of water some two miles in length. The fen is located in the northwest corner of the northwest quarter section of sec-



Figs. 7-10.—7. Details of a single series of teeth removed from the jaw, lateral view, showing the basal, surrounding membrane and projecting membranous plugs which fit into pits in the groove of the jaw, about 60 \times ; 8. Reproductive system, ventral view, dissected, about 2.3 \times . *Male*: t_1 and t_2 , testisacs (only the first 2 pairs are shown; actually 10 pairs exist); ve , vas efferens; vd , vas deferens; ep , epididymis or spermatic vesicle; eb , ejaculatory bulb; de , ductus ejaculatorius; gp , prostate gland; at , atrium or penis sheath; p , penis; ♂ male genital orifice. *Female*: os , ovisac; ga , albumen gland; vb , vaginal bulb; vs , vaginal stalk; ♀ female genital orifice. gX , $gXIV$, ganglia X, XIV; 9. Cocoon entire, lateral view, showing reticular outer covering and tube-like end canals, about 2.4 \times ; 10. LS through one end of cocoon, showing sac-within-sac structure and end canal plug, which plugs the canal and attaches the outer and inner capsules together with a button-like inner cap, about 2.9 \times .

Figs. 1-10. were made from recently killed and preserved leeches while observing through binocular dissecting microscope, except for the teeth, which necessitated the use of the compound microscope.

tion 32, Township 100 North, Range XXXVIII West, Dickinson County, Iowa. Though the area lies close to the lake, it has no water connection with the lake, but is saturated at all times by numerous springs. There are, however, small rivulets formed at lower levels which help effect drainage of the

output of the springs, and through which inundation waters from the lake may back up and also flood the lower reaches of the fen. (For a complete description of the fen see Anderson (1943).)

In the lower reaches or flats along the lake shore in a semi-aquatic/semi-terrestrial habitat, several hundred specimens and many egg cocoons have been collected from beneath old boards, logs and limbs, which are always some distance back from the shoreline of the lake, and beneath and mixed with the fallen accumulation of decaying cattails (*Typha latifolia*), sedges (*Scirpus americanus* and *S. validus*), reed grass (*Phragmites communis*), goldenrod (*Solidago graminifolia*), slough grass (*Spartina pectinata*) and *Carex* (several species), all kept moist by seepage from the upper parts of the fen. Besides the abundance of decaying vegetable matter, many snails (especially *Succinea*), slugs, earthworms and various insect larvae inhabit the area and serve as natural food or prey. *Haemopsis kingi* is the only leech which has been found in the fen; it has never been found in the lake proper.

One or all of such factors as chemical make-up, especially calcareousness and alkalinity, low, constant temperature, type of vegetation and abundance of natural food or prey, which contribute to the natural environment of this species may be significant in its distribution and frequency. The future may afford an answer after collections have been made in similar fens and specimens of the species are reported from other localities and habitats. One extensive area 25 miles east of Silver Lake Fen near Estherville, Emmett County, Iowa, is of similar physiography, physiognomy and chemistry, except that it drains into a river. Collections by the author in this area produced no specimens of the new species.

Reproduction.—As is true of most leeches, *Haemopsis kingi* when collected in the spring demonstrate rather interesting instinctive behavior: after their winter quiescence, they are voracious feeders, and after feeding greedily, copulate. In accomplishing this act the following ensues. The ventral surfaces of two leeches are brought together in the region of the genital pores, the anterior ends being pointed in opposite directions, comparable to the sexual union of two earthworms. As the filamentous penis is protruded it forces the contained spermatophore from its atrium into the vaginal stalk of the other leech. The transfer of a spermatophore may be reciprocal or one-way. From the spermatophore, the spermatozoa flow to the vaginal bulb where fertilization takes place. The spent spermatophore is discharged by muscular action of the vaginal stalk (spermatophores have been found in the vaginal stalks and spent ones in finger bowls from recently copulated leeches). The cocoons, which are produced in June, July and even August, depending upon the season, have been found under or mixed with decaying vegetation, under logs, and boards in the Silver Lake Fen and were produced under similar conditions in finger bowls in the laboratory. The cocoons seem to be hidden away in rather select places where their surroundings remain relatively moist or nearly saturated. In general structure, they are similar to those of the larger representatives of the family (e.g. *Macrobdella decora* and *Haemopsis marmoratis*) except they are smaller and possess a much less complex spongy outer covering. They are pale yellow or pale straw in color and range from 8 to nearly 12 mm long and 6 to 8 mm wide, the variation depending upon the size of the parent leech. The elliptically-shaped walls, 0.2 to 0.3 mm thick (not measuring the length

of the projecting appendages) are composed of a "cellular," reticular outer layer of chitinous material almost completely open at each end by a tube-like canal. Inside the outer tough layer is a thin, sac-like capsule of similar material which is also open at the end canals. The cocoon is virtually a sac-within-a-sac with the ends of both sacs perforated (figs. 9, 10). Within this sac is a viscous, albuminous material similar in appearance and composition to that found within the cocoons of earthworms. Embedded in this sticky substance are 5 to 9 eggs or developing embryos. The production of the inner capsule is similar to the formation of the earthworm cocoon; the outer reticular layer becomes an added complexity which is very resistant to desiccation and mechanical injury. It may be considered analogous to the slime tube in the earthworm. The actual description of the cocoon production (under laboratory conditions and probably very similar to natural ones) is as follows. The clitellar region and portion anterior becomes attenuated and the clitellum secretes and produces by rhythmical contractions and relaxations this chitinous material which forms the outer covering. At first this appears as a white, viscous, transparent mass, similar to many shiny bubbles clinging together, which surrounds the anterior of the leech with its "head" sticking out. As the mass is increased, the inner area becomes thickened and hardens to become the characteristic covering which is cell-like in configuration; the outer looser part becomes the spine-like projections or forms a reticular periphery (in the larger Hirudidae, as *Macrobdella decora* and *Haemopsis marmoratis*, this periphery is a much more complex, thick and spongy area). As the whitish, outer bubble-like area dries, it, also takes on the characteristic pale straw color, and as the walls between contiguous bubbles break down the reticulate or slightly spongelike structure results. As the leech withdraws, the inner capsule, which forms, as a separate secretion over the clitellum (and within which have been deposited the fertilized eggs and the mass of nutrient albumen, while the cocoon was still on the clitellum) slides over the anterior end of the leech. At the same time the anterior end canal is plugged with a rather firm, plastic material; the inner part of the canal and the perforated end of the inner capsule invaginate slightly as the leech pulls backwards and the pliable material of the canal plug is continued inward through the openings of the outer and inner capsules and a button-like cap is formed inside the inner capsule, which seals the canal opening and fastens the two capsules together (fig. 10). The posterior canal is plugged by a similar material and structure as the leech completely withdraws from the cocoon. These end canal plugs appear to be formed by the lip glands.

The cocoons hatch in about three weeks under laboratory conditions, temperature, 19-25°C. The young escape from the cocoons through the end canals. As hatching time nears, the inner albumen has reduced to a fraction of its original size and has pulled the now softened and smaller end canal plugs, to which it usually becomes attached, inward, thus opening the canals. The newly emerged young measure about 10 to 15 mm long and 2 mm wide when fully extended. The five pairs of eyes are plainly observable, even through the cocoon walls a few days before hatching. The early coloration and coloration after a few weeks have been described above. The jaws and teeth, in miniature, are present in the newly hatched young. The extensive sacculations of the crop, which show rather clearly through the nearly transparent body wall especially after feeding, have also been described. The newly emerged young suck

up mud containing decaying organic matter and about the fourth day accept, in addition, snail and earthworm flesh.

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A Catalogue of the Protozoa and Helminths of North American Rodents. II. Cestoda

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This is the second of four papers summarizing the host and geographical distribution records of the protozoa and helminths reported from North American rodents (order Rodentia). The organization and limitations of this part of the catalogue are the same as those outlined in Part I (Protozoa and Acanthocephala).

Cestoda

1. *Andrya americana* Stiles, 1895 [= *Monoecocystus americanus* (Stiles, 1895) Fuhrmann, 1932].—*Erethizon dorsatum* ssp. (117) (See Nos. 17, 18, 79, 81, 83, 105, 106, 108, 109, 111, 116).
2. *A. arctica* Rausch, 1952.—*Clethrionomys rutilus dawsoni*—Alas. (94); *Dicrostonyx groenlandicus* ssp.—Alas. (94); *D. g. richardsoni*—Man. (94); *D. g. rubricatus*—Alas. (94); *Lemmus trimucronatus alascensis*—Alas. (94); *Microtus miurus panacki*—Alas. (94).
3. *A. communis* Douthitt, 1915 [previously reported as *Anoplocephala* sp. by (36)]; = *Andrya primordialis* Douthitt, 1915 (3) (95).—*Clethrionomys gapperi galei* [Eutamias *g. galei*—Colo. (24) (36)]; *Microtus longicaudus* ssp.—Wash. (84); *M. montanus* ssp.—Wash. (84); *M. pennsylvanicus modestus*—Colo. (24) (36); *Peromyscus* sp.—Colo. (24) (36) (See No. 8).
4. *A. macrocephala* Douthitt, 1915.—*Citellus parryi lyratulus*—Alas. (94); *Geomys bursarius*—Nebr. (24), Minn. (39); *Microtus* ssp.—Mex. (91); *M. montanus nanus*—Wyo. (53); *M. ochrogaster*—No. Cent. States (99); *M. oeconomus innuitus*—Alas. (94); *M. o. macfarlanei*—Alas. (94); *M. pennsylvanicus drummondii*—No. Cent. States (99); *M. p. modestus*—Wyo. (95) (53); *M. p. pennsylvanicus*—Ohio, Mich. (88), No. Cent. States (99); *M. richardsoni macropus*—Wyo. (96) (53); *M. townsendii* ssp.—Wash. (95); *M. t. pugeti*—Wash. (95); *Sigmodon h. hispidus*—N. C. (95); *Thomomys talpoides tenellus*—Wyo. (95).
5. *A. microti* Hansen, 1947 [= *A. macrocephala* Douthitt, 1915 (95)].—*Microtus ochrogaster*—Nebr. (38) (39); *M. p. pennsylvanicus*—Wis. (99); *Sigmodon h. hispidus*—N. C. (42) (See Nos. 4, 7, 10, 92).
6. *A. neotomae* Voge, 1946.—*Neotoma cinerea* ssp.—Ore. (94); *N. fuscipes* ssp.—Calif. (130).
7. *A. ondratae* Rausch, 1948 [previously reported as *Andrya* sp. by (88)]; = *A. macrocephala* Douthitt, 1915 (99).—*Ondatra z. zibethica*—Ohio (89) (88) (See Nos. 4, 5, 10, 92).
8. *A. primordialis* Douthitt, 1915.—*Microtus montanus nanus*—Wyo. (53) (95); *M. pennsylvanicus modestus*—Wyo. (95) (53); *M. p. pennsylvanicus*—Ohio, Mich. (95); *M. richardsoni macropus*—Wyo. (95) (53); *Phenacomys i. intermedius*—Wyo. (94) (95); *Sciurus hudsonicus* ssp.—Minn. (24); *Tamiasciurus hudsonicus* ssp.—Wyo. (94); *T. h. ventorum*—Wyo. (95) (See No. 3).
9. *A. sciuri* Rausch, 1947.—*Glaucomys sabrinus macrotus*—Wis. (88) (98).
10. *A. transilucida* Douthitt, 1915 [= *A. macrocephala* Douthitt, 1915 (3) (99)].—*Geomys bursarius*—Minn. (24) (See Nos. 4, 5, 7, 92).
11. *A. sp. (primordialis or macrocephala ?)*.—*Microtus richardsoni macropus*—Wyo. (53).
12. *A. sp.*—*Microtus p. pennsylvanicus*—Mich. (99); *Neotoma floridana osagenis*—Okla. (75); *Synaptomys c. cooperi*—Minn. (?) (29).
13. *Anomotaenia telescopica* Barker and Andrews, 1915.—*Ondatra z. zibethica* [Fiber *zibethicus*—Nebr. (?) (5)].
14. *Anoplocephala infrequens* Douthitt, 1915 [= *Paranoplocephala infrequens* (Douthitt, 1915) Baer, 1927 (115)]—*Clethrionomys* (?) sp. [Eutamias (?) sp.—N.D. (24)]; *Geomys bursarius*—Minn., Man. (24) (See Nos. 15, 16, 90, 91, 96, 97).
15. *A. variabilis* Douthitt, 1915 [= *Paranoplocephala variabilis* (Douthitt, 1915) Baer, 1927 (136) (94)]; = *P. infrequens* (Douthitt, 1915) Baer, 1927 (3) (38)].—*Geomys bursarius*—Ill., Minn. (24) (See Nos. 14, 16, 90, 91, 96, 97).
16. *A. variabilis* var. *borealis* Douthitt, 1915 [= *Paranoplocephala variabilis* (Douthitt, 1915) Baer, 1927 (94)].—*Geomys bursarius*—N.D. (24) (See Nos. 14, 15, 90, 91, 96, 97).
17. *Bertiella americana* (Stiles, 1895) Stiles, 1896 [= *Monoecocystus americanus* (Stiles, 1895) Fuhrmann, 1932; = *Schizotaenia* (= *Monoecocystus*) *variabilis* (3)].—*Erethizon epixanthum* ssp.—N.Y. (118), Wyo. (118) (See Nos. 1, 18, 79, 81, 83, 105, 106, 108, 109, 111, 116).
18. *Bertiella americana* (Stiles, 1895) Stiles and Hassall, 1902 [= *M. americanus* (Stiles, 1895) (32)].—*Erethizon dorsatum* ssp.—N.Y. (118) (See Nos. 1, 17, 79, 81, 83, 105, 106, 109, 111, 116).

* This work was started at the University of California, Los Angeles.

19. *Catenotaenia dendritica* (Goeze, 1782) Janicki, 1904 [erroneous report as *C. pusilla* (Goeze) by (98)]; *Clethrionomys gapperi cascadenis*—Wash. (94); *C. rutilus dawsoni*—Alas. (94); *Glaucomys sabrinus macrotis*—Wis., Mich. and/or Ohio (92) (98); *Sciurus niger rufiventer*—Wis., Mich. and/or Ohio (92) (98).
20. *C. linsdalei* McIntosh, 1941.—*Dipodomys heermanni* ssp.—Calif. (132); *D. venustus* ssp.—Calif. (132) *Perognathus californicus* ssp.—Calif. (132); *Thomomys b. bottae*—Calif. (69).
21. *C. pusilla* (Goeze, 1782) Janicki, 1904.—*Pitymys pinetorum* ssp.—Pa. (15); *Rattus norvegicus*—U.S. (57); *R. rattus*—U.S. (78) (See No. 122).
22. *C. reggiei* Kausch, 1951.—*Marmota* (See No. 122).
23. *C. sp.*—*Sciurus niger rufiventer*—Kan. (34) (128).
24. *C. sp.* of Katz, 1938 (*pusilla* ?)—*Sciurus c. carolinensis*—Ohio (50).
25. "cestode".—*Citellus lateralis* ssp. [*Callospermophilus lateralis* ssp.—Colo. (36)]; *C. tridecemlineatus pallidus*—Colo. (36); *Microtus pennsylvanicus* ssp.—N.Y. (26); *Neotoma cinerea rupicola*—Colo. (36); *N. floridana baileyi*—Colo. (36); *Ondatra z. zibethica*—N.Y. (26); *Tamiasciurus* ssp.—Mich. (98); *Thomomys* sp.—Colo. (36); *T. fossor*—Colo. (36).
26. "cestode" (larval).—*Cynomys ludovicianus* ssp. [*C. leucurus* ssp.—Wyo. (110)]; *Ondatra zibethica* ssp.—Mich. (1); *Peromyscus leucopus niveboracensis*—Minn. (29) (28); *Sciurus carolinensis* ssp.—Md., Va. (108).
27. *Choanotaenia nebrascensis* Hansen, 1950.—*Microtus ochrogaster*—Nebr. (39); *Sciurus niger rufiventer*—Nebr. (39) [*S. rufiventer*—Nebr. (39)].
28. *C. peromysci* (Erickson, 1938) Hansen, 1950.—(See No. 100).
29. *C. sciuricola* Harwood and Cooke, 1949.—*Sciurus niger* ssp.—Ohio (43).
30. *C. spermophilus* (McLeod, 1933) Hansen, 1950.—(See No. 101).
31. *C. sp.*—(See No. 102).
32. *C. sp.* (*nebrascensis* ?)—*Microtus ochrogaster*—Ill. (99).
33. *Cititaelia megasacca* Smith, 1951.—*Thomomys talpoides clusius*—Wyo. (115).
34. *C. pectinata* (Goeze, 1782) Stiles and Hassall, 1896.—(See Nos. 41, 119).
35. *C. pectinata* var. *americana* Douthitt, 1915.—*Sciurus carolinensis leucotis*—Mass. (85).
36. *C. praecoquis* (Stiles, 1895) Stiles and Hassall, 1896.—*Neofiber alleni nigerescens*—Fla. (93); *Thomomys talpoides clusius*—Wyo. (115) (See No. 42).
37. *C. sp.*—*Geomys bursarius*—Minn. (24).
38. *Cladotaenia* sp.—*Geomys bursarius* [*Cynomys bursarius*—Wyo. (110)]; *Cynomys ludovicianus* sp. [*C. leucurus* ssp.—Wyo. (109)]; *Microtus ochrogaster*—No. Cent. States (99); *M. p. pennsylvanicus*—No. Cent. States (99); *Ondatra zibethica* ssp.—B.C. (52); *Pitymys pinetorum scalopoides* [*Microtus pinetorum scalopoides*—Mich. (81)]; *Peromyscus maniculatus* ssp. (29); *P. leucopus niveboracensis*—Mich. (81).
39. *Coenurus serialis* Gervais, 1847 [larval form of *Multiceps serialis* (Gervais, 1847) Stiles and Stevenson, 1905].—*Sciurus niger rufiventer*—Nebr. (64) (See Nos. 40, 84, 86).
40. *C. sp.* [*Multiceps* sp. (71); = *M. serialis* (Gervais) (72)].—*Rattus norvegicus* [*Mus decumanus* (127)]; *Sciurus* sp.—U.S. (18) (See Nos. 39, 84, 86).
41. *Ctenotaenia marmotae* (Froelich) Stiles and Hassall, 1896 [*Cititaelia pectinata* (Goeze, 1782) Stiles and Hassall, 1896 (3)].—*Marmota m. monax* [*Arctomys marmotae* (120)] (See Nos. 34, 119).
42. *C. praecoquis* Stiles, 1895 [= *Cititaelia praecoquis* (Stiles, 1895) Stiles and Hassall, 1896].—*Geomys bursarius* (117) (See No. 36).
43. *Cysticercus cellulosae* Küchenmeister and Zurn, 1878 (larval form of *Taenia solium* Linnaeus, 1758).—*R. rattus* [*Mus rattus* (119)] (See No. 123).
44. *C. fasciolaris* Rudolphi, 1808 [larval form of *Taenia taeniaeformis* (Batsch, 1786)].—*Mus musculus*—D.C. (120); *M. m. "albus"* (122) (114); *Neotoma cinerea* ssp.—Wash. (84); *Ondatra zibethica* ssp.—Mich. (1), Ont. (55); *O. z. zibethica* [*Fiber zibethicus*—Md. (120), Pa. (62) (114)]; *Rattus norvegicus*—Md. (63), D.C. (83), N.Y. (45), Ohio (31), Ind. (11), Ill. (25), Mo. (126), Ont. (30), Mex. (140) *Mus decumanus*—D.C. (120) (58) (59); *R. r. norvegicus*—Mex. (10); *R. n. "albus"* (114) [*Mus rattus* "albus" (122)]; *R. rattus* [*Mus rattus alexandrinus* (122); *R. r. friegivorus*—Texas (47)]; "rat" (*R. norvegicus* ?)—Miss. (135); *Sciurus niger rufiventer*—Nebr. (64), Kan. (23); *Sigmodon hispidus* ssp.—SW U.S. (7); *S. h. hispidus*—Texas (47) (See No. 49).
45. *C. marginata* Batsch, 1786 [= *Taenia hydatigena* Pallas, 1766 (71)].—*Mus musculus*—Md. (120) (See No. 115).
46. *C. passeriformes* Baumgartner, 1940.—*Sciurus niger rufiventer*—Ohio (6).
47. *C. pisiformes* Zeder, 1803 [larval form of *Taenia pisiformis* (Bloch, 1780)].—*Ondatra zibethica* ssp.—Mass. (85).
48. *C. portatae* Wellman and Wherry, 1910 [larval form of *Taenia portatae* (Wellman and Wherry, 1910) (71)].—*Citellus b. beecheyi* [*Otospermophilus beecheyi*—Calif. (138)].
49. *C. talpae* Rudolphi, 1819 [larval form of *Taenia tenuicollis* Rudolphi, 1819; = *C. fasciolaris* Rudolphi (1)].—*Ondatra zibethica* ssp.—Ont. (112); *O. z. spatulata* [*O. spatulata*—Ont. (112)] (See No. 44).
50. *C. tenuicollis* Rudolphi, 1810 (larval form of *Taenia tenuicollis* Rudolphi, 1819).—*Sciurus niger rufiventer*—Texas (14).
51. *C. sp.*—*Citellus t. tridecemlineatus*—Wis. (98); *Neotoma fuscipes annectens*—Calif. (129); *Ondatra z. zibethica*—Maine (73).
52. *C. sp.* of Skinner, 1935 (larval of *Taenia lynchis* ?).—*Peromyscus maniculatus nubiterrae*—Tenn. (113) (See No. 129).
53. *Davainea* sp. of Douthitt, 1915 [referred to as *Railletina* sp. by (71)].—*Geomys breviceps* ssp.—Okla. (24) (See No. 104).
54. *Diandra composita* Darrah, 1930.—*Marmota caligata broweri*—Alas. (92); *Marmota flaviventris nosophora*—Wyo. (22).
55. *D. (composita)* ? sp. of Philip, 1938.—*Marmota c. caligata*—Alas. (82).
56. *Diphyllobothrium (mansonoides)* ? (*pleuroceroides*).—*Peromyscus g. gossypinus*—Fla. (67).

57. *Dithyridium elongatum* (Blumberg, 1882) [(?) larval form of *Mesocostoides lineatus* (Goeze, 1792) (49) (139)].—*Rattus norvegicus*—U.S. (78). (See Nos. 74, 76).
58. *Echinococcus granulosus* (Batsch, 1786) Rudolphi, 1805 (larval).—*Microtus oeconomus inuitus*—Alas. (106) (97).
59. *E. sp.* (larval).—*Clethrionomys rutilus albiventer*—Alas. (94).
60. *Hymenolepis citelli* (McLeod, 1933) Hughes, 1941 [= *H. diminuta* (Rudolphi) (99)].—*Citellus beecheyi* ssp.—Calif. (61) (See Nos. 61, 114, 130).
61. *H. diminuta* (Rudolphi, 1819) Blanchard, 1891.—*Citellus* sp. [*Spermophilus* sp.—U.S. (48)]; *C. franklinii*—Wis. (98); *C. tridecemlineatus* ssp.—Nebr. (39); *C. t. tridecemlineatus*—Wis., Minn. (98); *Microtus longicaudus* ssp.—Wash. (84); *Mus musculus*—N.C. (40), Texas (12); *M. m. "albus"* (122); *Neotoma cinerea* ssp.—Wash. (84); *Peromyscus maniculatus* ssp.—Wash. (84); "rat" (*R. norvegicus*?)—Miss. (135); *Rattus norvegicus*—D.C. (83), Md. (63), N.Y. (45), N.C. (40), Ohio (31), Ind. (11), Wis. (105), Mo. (126), Nebr. (39), Calif. (134) (65), Can. (30), Mex. (140) [*Epimys norvegicus*—Texas (12); *Mus decumanus*—D.C. (120); *M. norvegicus*—Wis. (74); *R. rattus norvegicus*—Mex. (10)]; *R. rattus*—Calif. (134) [*Mus rattus alexandrinus* (122); *M. rattus*—U.S. (119); *R. rattus friegiorius*—Texas (47)]; *Reithrodontomys megalotis* ssp.—Wash. (84); *Sciurus niger rufiventer*—Wis. (98); *Sigmodon h. hispidus*—N.C. (40) (42); *S. h. texianus*—Texas (114); *Tamias striatus* ssp.—Wis. (98); *Thomomys talpoides* ssp.—Wash. (84) (See Nos. 60, 114, 130).
62. *H. evaginata* Barker and Andrews, 1915—*Microtus pennsylvanicus* ssp.—N.Y. (26); *M. p. pennsylvanicus*—Wis. (99); *Ondatra zibethica* ssp.—Mass. (85), Mich. (1), Ont. (55); *O. z. osoyoensis*—Colo. (4); *O. z. rivalica*—La. (80); *O. z. zibethica*—Minn. (81), Maine (73), N.Y. (26) [*Fiber zibethicus*—Nebr. (5)]; *O. z. macrodon*—Md. (79).
63. *H. fraterna* Stiles, 1906 [*H. nana* (Siebold, 1852) (72) and others].—*Microtus p. pennsylvanicus*—Ohio (99); *Mus musculus* "albus"—Md. (111); *Rattus norvegicus*—Md. (111), Alas. (102) [*Epimys norvegicus*—Md. (111)] (See Nos. 67, 68, 69).
64. *H. horrida* (Linstow, 1900) Linstow, 1901.—*Clethrionomys gapperi* ssp.—Que. (103); *C. e. cascadenis*—Wash. (102); *C. rutilus dawsoni*—Wash. (103); *C. urangeli*—Alas. (103); *Dicrostonyx* ssp.—Alas. (53); *D. groenlandicus rubricatus*—Alas. (90) (53); *Lemmus trimucronatus alascensis*—Alas. (90); *L. t. harroldi*—Alas. (103); *Microtus longicaudus* ssp.—Mont. (103); *M. ochrogaster*—Tenn. (91); *M. chrotorrhinus* (? *ravus*)—Que. (103); *M. miurus panakei*—Alas. (103); *M. montanus nanus*—Wyo. (53); *M. pennsylvanicus modestus*—Mont. (103); *M. richardsoni arviculoides*—Mont. (103); *M. r. macrodon*—Wyo. (53); *Perognathus californicus* ssp.—Calif. (134); *Peromyscus boylii* ssp.—Calif. (134); *P. californicus* ssp.—Calif. (134); *P. truei* ssp.—Calif. (134); *Tamiasciurus hudsonicus* ssp.—Wyo. (103); *Thomomys bottae* ssp.—Calif. (134).
65. *H. johnsoni* Schiller, 1952.—*Microtus pennsylvanicus drummondii*—Can. (104), Alas. (94).
66. *H. microstoma* (Dujardin, 1845) Blanchard, 1891.—*R. rattus* [*Mus rattus*—Md. (77)]; *Sigmodon h. hispidus*—N.C. (41) (42).
67. *H. murina* (Dujardin, 1845) Blanchard, 1891 [= *H. fraterna* Stiles, 1906 (48)] = *H. nana* (Siebold, 1852) (72)].—*Mus musculus*—D.C. (120); *Rattus norvegicus*—Ont. (30); *Epimys norvegicus*—Texas (12); *R. rattus* [*Mus rattus alexandrinus* (122)] (See Nos. 63, 68, 69).
68. *H. nana* (Siebold, 1852) Blanchard, 1891—"rat" (*R. norvegicus*?)—Miss. (135); *R. norvegicus*—N.Y. (45), D.C. (83), N.C. (40), Ohio (31), Ind. (11), Wis. (105), Mo. (126), Nebr. (39), Mex. (140); *R. norvegicus* "albus" (20) (See Nos. 63, 67, 69).
69. *H. nana* var. *fraterna* Stiles, 1906 [= *H. nana*—various authors; = *H. fraterna*—various authors].—*Rattus norvegicus*—Md. (63) [*R. rattus norvegicus*—Mex. (10)] (See Nos. 63, 67, 68).
70. *H. octocoronata* (Linstow, 1879) Meggitt, 1924.—*Ondatra zibethica osoyoensis*—B.C. (52).
71. *H. ondatrae* Rider and Macy, 1947.—*Ondatra zibethica occipitalis*—Ore. (101).
72. *H. oregonensis* Neiland and Senger, 1952.—*Ondatra zibethica occipitalis*—Ore. (76).
73. *H. sp.*—*Cynomys ludovicianus* ssp.—Colo. (36); *Geomys brevicaeps* ssp.—Okla., Texas (24); *G. b. brevicaeps*—Texas (27); *G. bursarius*—Ill., Minn., N.D. (24); *G. personatus* fallax—Texas (24); *Microtus ochrogaster*—Ill. (99); *Ondatra zibethica* ssp.—Ohio (86), Ill. (125), Ala. (123); *Peromyscus maniculatus* ssp.—Nebr. (39); *P. m. gracilis*—Minn. (29); *Sciurus c. carolinensis*—Ohio (50); *P. niger rufiventer*—Ohio (6) (50); *Tamias striatus* ssp.—Wis. (98).
74. *Mesocostoides cortii* Hoeppli, 1925 [= *M. lineatus* (Goeze, 1782) (72)].—*Mus musculus*—Colo. (46) (See Nos. 57, 76).
75. *M. latus* Mueller, 1927.—*Sciurus niger rufiventer*—Mich. (98).
76. *M. lineatus* (Goeze, 1782) Railliet, 1893.—*Mus musculus*—U.S. (37) (See Nos. 57, 74).
77. *M. lineatus* (Goeze) (larval).—*Rattus norvegicus*—U.S. (78).
78. *M. sp.* (kirbyii or variabilis?) (tetrahyridium).—*Peromyscus boylii rowleyi*—Calif. (137).
79. *Monococcestus americanus* (Stiles, 1895) Fuhrmann, 1932. (See Nos. 1, 17, 18, 81, 83, 105, 106, 108, 109, 111, 116).
80. *M. anoplocephaloides* (Douthitt, 1915).—(See No. 107).
81. *M. erethizontis* Beddard, 1914 [= *Monococcestus americanus* (Stiles, 1895) (13) (79)].—*Erethizon dorsatum* ssp. (8) (See Nos. 1, 17, 18, 79, 83, 105, 106, 108, 109, 111, 116).
82. *M. sigmodontis* (Chandler and Suttles, 1922) Smith, 1951.—*Sigmodon h. hispidus*—Texas (47) (See No. 110).
83. *M. variabilis* (Douthitt, 1915). (See Nos. 1, 17, 18, 79, 81, 105, 106, 108, 109, 111, 116).
84. *Multiceps serialis* (Gervais, 1847) Stiles and Stevenson, 1905 (larval).—*Sciurus carolinensis* ssp.—U.S. (35); *S. niger neglectus*—U.S. (37); *S. n. rufiventer*—Nebr. (64) [*S. rufiventer* (37)] (See Nos. 39, 40, 86).
85. *M. twitchelli* (Schwartz, 1924). (See No. 126).
86. *M. sp.*—(See Nos. 39, 40, 84).

87. *Oöchoristina ratti* Yamaguti and Miyata, 1937 [*O. symmetrica* (Baylis, 1927) (39)].—*Mus musculus*—Ill. (100); *R. rattus* [*R. r. frigidus*—Texas (47)] (See No. 88).
88. *O. symmetrica* (Baylis, 1927) Perry, 1939.—*Mus musculus*—Nebr. (39) (See No. 87).
89. *O. sp.*—*Geomys bursarius*—Minn. (24).
90. *Paranoplocephala borealis* (Douthitt, 1915) Rausch and Tiner, 1949 [= *P. variabilis* (Douthitt, 1915) (94)].—*Microtus* sp.—Ore. (94); *M. montanus nanus*—Wyo. (53); *M. ochrogaster*—Nebr. (94); *M. p. pennsylvanicus*—Wis., Ohio, Ill. (94); *Synaptomys cooperi*—Ill. (94); *Thomomys talpoides tenellus*—Wyo. (94) (See Nos. 14, 15, 16, 91, 96, 97).
91. *P. infrequens* (Douthitt, 1915) Baer, 1927.—*Geomys bursarius*—Minn. (24); *Microtus longicaudus mordax*—Wyo. (53); *M. miurus paneaki*—Alas. (94); *M. mogollonensis*—Ariz. (94); *M. montanus nanus*—Wyo. (94) (53); *M. ochrogaster*—(96), Nebr. (39) (38); *M. oregonensis macfarlandi*—Alas. (94); *M. pennsylvanicus drummondii*—Alas. (94); *M. p. modestus* (94); Wyo. (33) (96); *M. p. pennsylvanicus* (96), N.Y., Ohio, Mich., Wis. (94); *M. richardsoni macropus*—Wyo. (94) (53); *M. (?) sp.*—Minn. (24) (See Nos. 14, 15, 16, 90, 96, 97).
92. *P. kirbyi* Voge, 1948 [*Andrya macrocephala* Douthitt, 1915 (94)].—*Microtus c. californicus*—Calif. (131) (See Nos. 4, 5, 7, 10).
93. *P. lemni* Rausch, 1952 [previously reported as *P. infrequens* by (94)].—*Lemmus trimucronatus harroldi*—Alas. (94); *L. t. alascensis*—Alas. (90) (94); *L. t. trimucronatus*—Alas. (94).
94. *P. neofibrinus* Rausch, 1952.—*Neofiber alleni nigrescens*—Fla. (93).
95. *P. anophalodes* (Hermann, 1783) Lühse, 1910.—*Microtus miurus paneaki*—Alas. (94); *Sigmodon h. hispidus*—N.C. (41).
96. *P. trochii* Rausch, 1946 [= *P. infrequens* (Douthitt, 1915) (96)].—*Microtus ochrogaster*—Nebr. (38); *M. p. pennsylvanicus*—Ohio, Mich. (86), No. Cent. States (99) (See Nos. 14, 15, 16, 90, 91, 97).
97. *P. variabilis* (Douthitt, 1915) Baer, 1927 [= *P. infrequens* (Douthitt, 1915) (3) (115)].—*Microtus montanus nanus*—Wyo. (53) (See Nos. 14, 15, 16, 90, 91, 96).
98. *P. sp.*—*Microtus ochrogaster*—No. Cent. States (99); *M. sp.*—(96).
99. *P. sp.* of Rausch and Tiner, 1949 [previously reported as *Andrya* sp. by (29)].—*Clethrionomys g. gapperi*—Minn. (29); *Microtus p. pennsylvanicus*—Mich., Minn. (29).
100. *Prochaonotaenia peromysci* Erickson, 1938 [= *Choanotaenia peromysci* (Erickson, 1938) Hansen, 1950].—*Peromyscus maniculatus gracilis*—Minn. (29) (See No. 28).
101. *P. spermophilus* McLeod, 1933 [= *Choanotaenia spermophilus* (McLeod, 1933) Hansen, 1950].—*Citellus richardsoni* ssp.—Man. (70); *C. tridecemlineatus* ssp.—Man. (70) (See No. 30).
102. *P. sp. (peromysci ?)* of Erickson, 1938 [= *Choanotaenia* sp. (*peromysci* ?) (39)].—*Peromyscus maniculatus gracilis*—Minn. (28) (See No. 31).
103. *Railletina (R.) bakeri* Chandler, 1942.—*Sigmodon hispidus* sp.—SW U.S. (7); *S. n. hispidus*—N.C. (41) (42), Texas (47); *Sciurus niger rufiventer*—Texas (12).
104. *R. sp.*—(See No. 53).
105. *Schizotaenia americana* (Stiles, 1895) Janicki, 1906 [= *Monoeoceustus americana* (Stiles, 1895) Fuhrmann, 1932].—*Erethizon d. dorsatum*—N.H. (51); *E. dorsatum* ssp.—Mass. (85), Minn. (2); *E. epixanthum* ssp.—Wyo. (24), Colo. (13), Ariz. (124); *Ondatra z. zibethica*—Minn. (79) (See Nos. 1, 17, 18, 79, 81, 83, 106, 108, 109, 111, 116).
106. *S. (=Monoeoceustus americana* of Cohn, 1906 [*Schizotaenia* (= *Monoeoceustus*) *variabilis* (24)]].—*Erethizon epixanthum* ssp.—Alas. (19) (See Nos. 1, 17, 18, 79, 81, 83, 105, 108, 109, 111, 116).
107. *S. anoplocephaloides* Douthitt, 1915 [= *Monoeoceustus anoplocephaloides* (Douthitt, 1915) (115)].—*Geomys breviceps* ssp.—Okla. (24); *Thomomys b. bottae*—Calif. (39). (See No. 80).
108. *S. erethizontis* (Beddard, 1914) Baer, 1925 [= *Monoeoceustus variabilis* (Douthitt, 1915) (32); = *M. americanus* (Stiles, 1895) (13)].—*Erethizon d. dorsatum*—Maine (21) (See Nos. 1, 17, 18, 79, 81, 83, 105, 106, 108, 111, 116).
109. *S. laticephala* (Leidy, 1855) Meggitt, 1924 [= *Monoeoceustus americanus* (Stiles, 1895) Fuhrmann, 1932 (48)].—*Erethizon d. dorsatum*—Maine (21); *E. epixanthum* ssp. (71) (See Nos. 1, 17, 18, 79, 81, 83, 105, 106, 108, 111, 116).
110. *S. sigmodontis* Chandler and Suttles, 1922 [= *Monoeoceustus sigmodontis* (Chandler and Suttles, 1922) (115)].—*Sigmodon hispidus* ssp.—SW U.S. (7), Fla. (66); *S. h. hispidus*—Ga. (42); *S. h. texianus*—Texas (16) (See No. 82).
111. *S. variabilis* Douthitt, 1915 [= *Monoeoceustus variabilis* (Douthitt, 1915) (32); = *M. erethizontis* Beddard, 1914 (3)].—*Erethizon dorsatum* ssp.—N.Y. (24); *E. epixanthum* ssp.—Ariz. (124), Colo. (13), Alas. (24); *Ondatra z. zibethica*—Minn. (79) (See Nos. 1, 17, 18, 79, 81, 83, 105, 106, 108, 109, 116).
112. *Taenia crassicolis* Rudolphi, 1810 [= *T. taeniaeformis* (Batsch, 1786) (48)].—*Ondatra zibethica macrodon*—Md. (116) [*Fiber zibethicus macrodon*—Md. (56)] (See No. 124).
113. *T. crassiceps* (Zeder, 1800) Rudolphi, 1810 (larval).—*Dicrostonyx groenlandicus richardsonii*—Man. (94); *Lemmus t. trimucronatus*—Alas. (94).
114. *T. diminuta* Rudolphi, 1819 [= *Hymenolepis diminuta* (Rudolphi, 1819) (48)].—*Rattus norvegicus* [*Mus decumanus* (59)] (See Nos. 60, 61, 130).
115. *T. hydatigena* Pallas, 1766.—*Rattus norvegicus*—U.S. (78); *R. rattus*—U.S. (78); *Sciurus niger* ssp.—(37); *S. n. neglectus*—U.S. (37) (See No. 45).
116. *T. laticephala* Leidy, 1855 [= *Monoeoceustus americanus* (Stiles, 1895) (32)].—*Erethizon dorsatum* ssp. (58); *E. d. dorsatum* [*Hystrix dorsata* (57)]; *R. rattus* [*Mus rattus alexandrinus* (122)] (See Nos. 1, 17, 18, 79, 81, 83, 105, 106, 108, 109, 111).
117. *T. lynchii* (?) Skinner, 1935 (larval).—*Sigmodon h. hispidus*—Ga. (42).
118. *T. michiganensis* Gower, 1939 (larval).—*Erethizon d. dorsatum*—Mich. (33).
119. *T. pectinata* Goetze, 1782 [= *Cittotaenia pectinata* (Goetze, 1782) Stiles and Hassall, 1896].—*Erethizon d. dorsatum* [*Hystrix dorsata* (17)] (See No. 34, 41).
120. *T. pisiformis* (Bloch, 1780) Gmelin, 1790 (larval).—*Apodonta rufa* ssp.—U.S. (37);

Mus musculus—U.S. (37); *R. rattus*—U.S. (78); *Sciurus niger rufiventer*—Wis. (98), Ill. (9), Kan. (34) (128).

121. *T. portallae* (Wellman and Wherry, 1910) Meggitt, 1924 (larval).—*Citellus beecheyi* ssp.—Calif. (61).

122. *T. pusilla* Goeze, 1782 [= *Catenotaenia pusilla* (Goeze, 1782) Janicki, 1904].—*Rattus norvegicus* [*Mus decumanus* (57)] (See No. 21).

123. *T. solium* Linnaeus, 1858 (larval).—*R. rattus*—U.S. (78) (See No. 43).

124. *T. taeniaeformis* (Batsch, 1786) Wolffhügel, 1911 (probably all larval).—*Microtus ochrogaster*—No. Cent. States (99); *M. p. pennsylvanicus*—Minn. (29), No. Cent. States (99); *Mus musculus*—U.S. (37), N.C. (40), Calif. (65); *Neotoma floridana osagensis*—Okla. (75); *Ondatra zibethica* ssp.—Mich. (54), Ohio (125), Ill. (86), U.S. (37); *O. z. occidentalis*—Ore. (101); *O. z. zibethica*—N.Y. (26); *Rattus norvegicus*—N.C. (40), Colo. (37), Alas. (102); *R. rattus* [*Epimys rattus alexandrinus*—U.S. (37); *Epimys r. rattus*—U.S. (37)]; *Sciurus c. carolinensis*—N.C. (40); *S. niger rufiventer*—Mich. (98), Nebr., Kan. (23); *Sigmodon h. hispidus*—Ga., N.C. (41) (42), S.C. (44) (See No. 112).

125. *T. tenuicollis* Rudolphi, 1819 (larval) [previously reported as *Gladotaenia* sp. by (90) (99)].—*Clethrionomys rutilus dawsoni*—Alas. (94); *Lemmus trimucronatus alasensis*—Alas. (94); *Microtus miurus paneaki*—Alas. (94).

126. *T. twitchelli* Schwartz, 1924 (larval) [= *Multiceps twitchelli* (Schwartz, 1924) (71)].—*Erethizon epixanthum* (*myops* ?)—Alas. (107) (See No. 85).

127. *T. sp.* (larval ?)—*Citellus townsendii* [*Spermophilus townsendii*—Md. (120)]; *Erethizon dorsatum* ssp.—D.C. (120); *E. epixanthum* ssp.—Colo. (36); *Tamias striatus* ssp.—(120).

128. *T. sp.* (larval).—*Citellus beecheyi* ssp.—Calif. (61); *Peromyscus leucopus noveboracensis* (29); *Pitomyz p. pinetorum* (29); *Microtus pennsylvanicus drummondii*—No. Cent. States (99).

129. *T. sp.* (lynchis ?) (larval).—*Neofiber alleni nigrescens*—Fla. (93) (See No. 52).

130. *Weinlandia citelli* McLeod, 1933 [= *Hymenolepis citelli* (McLeod, 1933) Hughes, 1941].—*Citellus franklinii*—Man. (70); *C. richardsoni* ssp.—Man. (70); *C. tridecemlineatus* ssp.—Man. (70) (See Nos. 60, 61, 114).

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HOST-INDEX TO PARTS I AND II

P=Protozoa; A=Acanthocephala; C=Cestoda. Numbers refer to the numbers preceding the parasite names listed under these three categories.

ERETHIZONTIDAE

ERETHIZON F. Cuvier (porcupines).—*E. dorsatum* ssp.: P-14; C-1, 18, 81, 105, 111, 116, 127. *E. d. dorsatum*: C-105, 106, 108, 109, 116, 118, 119. *E. epixanthum* ssp.: C-17, 105, 109, 111, 116, 126, 127, 128.

CASTORIDAE

APLODONTIA Richardson (mountain-beavers).—*A. rufa* ssp.: C-120.
Castor Linnaeus (beavers).—C. sp.: P-14.

CRICETIDAE

CLETHRIONOMYS Tilesius (red-backed mice).—*C. lorac*
C. g. cascadenis: C-19, 64. *C. g. galei*: C-3. *C. g. gapperi*: C-99. *C. g. saturatus*: P-121. *C. rutilus albiventer*: C-59. *C. r. dawsoni*: C-2, 19, 64, 125. *C. wranglei*: C-64.
DICROSTONYX Glober (collard-lemmings).—*D.* sp.: C-64. *D. groenlandicus* ssp.: C-2. *D. g. richardsonii*: P-25; C-2, 113. *D. g. rubricatus*: C-2, 64.
HODOMYS Merriam.—*H. allenii*: P-19.
LEMMUS Link (lemmings).—*L. trimucronatus alascensis*: C-2, 64, 93, 125. *L. t. haroldi*: C-64, 98. *L. t. trimucronatus*: C-93, 113.
MICROTUS Schrank (meadow-mice).—*M.* sp.: P-64; C-87, 90, 91, 98. *M. californicus* ssp.: P-68, 125, 134. *M. c. californicus*: P-64, 65; C-92. *M. c. sanctigiegi*: P-125. *M. chrotorrhinus rarus*: C-64. *M. longicaudus* ssp.: C-3, 61, 64. *M. l. mordax*: C-91. *M. mexicanus* ssp.: C-4. *M. miurus paneaki*: C-2, 64, 91, 95, 125. *M. mogollonensis*: C-91. *M. montanus* ssp.: C-3. *M. m. nanus*: C-4, 8, 64, 90, 91, 97. *M. ochrogaster*: C-4, 5, 27, 32, 38, 64, 73, 90, 91, 96, 98, 124. *M. oeconomus innuitus*: C-4, 58. *M. o. macfarlanei*: C-4, 91. *M. pennsylvanicus* ssp.: P-89, 105, 125; C-25, 62. *M. p. acadii*: P-64. *M. p. drummondi*: C-4, 65, 91, 128. *M. p. modestus*: C-3, 4, 8, 64, 91. *M. p. pennsyl.*

vanicus: P-3, 72, 83, 133; C-4, 5, 8, 12, 38, 62, 63, 90, 91, 96, 99, 124. *M. richardsonii arviculoides*: C-64. *M. r. macropus*: C-4, 8, 11, 64, 91. *M. townsendii* ssp.: C-4. *M. t. pugeti*: C-4.

NEOFIBER True (round-tailed muskrats).—*N. allenii nigrescens*: C-36, 94, 129.

NEOTOMA Say and Ord (wood-rats).—*N.* sp.: A-11. *N. albigula albigula*: P-119, 126, 133. *N. a. melanura*: P-126. *N. cinerea* ssp.: C-6, 44, 61. *N. c. rupicola*: C-25. *N. floridana baileyi*: C-25. *N. f. osagensis*: C-12, 124. *N. fuscipes* ssp.: P-13, 14, 36, 40, 107, 119; C-6. *N. f. annectens*: P-119, 124, 126; C-51. *N. f. macrotis*: P-119, 124, 126. *N. lepida* ssp.: P-114. *N. l. lepida*: P-126. *N. l. monstrabilis*: P-36, 40. *N. micropus* ssp.: P-124. *N. m. micropus*: P-119.

ONDATRA Link (muskrats).—*O. zibethica* ssp.: P-14, 37, 43, 65, 66, 89, 112; A-13; C-26, 38, 44, 47, 49, 73, 124. *O. z. macrodon*: C-62, 112. *O. z. occipitalis*: C-71, 72, 112, 124. *O. z. osoyooensis*: P-66; C-62, 70. *O. z. rivalica*: P-70, 112; C-62. *O. z. spatulata*: C-49. *O. z. zibethica*: C-13, 25, 44, 51, 62, 105, 111, 124.

ONYCHOMYS Baird (grasshopper-mice).—*O. torridus* ssp.: A-7.

PEROMYSCUS Glover (white-footed mice).—*P.* sp.: C-3. *P. boylii* ssp.: P-134; C-64. *P. b. rowleyi*: P-119, 129; C-78. *P. californicus* ssp.: P-61, 114; C-74. *P. c. insignis*: P-129. *P. gossypinus gossypinus*: C-56. *P. leucopus* ssp.: P-10, 78, 89, 105, 115. *P. l. leucopus*: P-59, 64, 107. *P. l. noveboracensis*: C-28, 38, 128. *P. maniculatus* ssp.: P-129, 134; C-38, 61, 73. *P. m. blandus*: P-129. *P. m. gambelii*: P-64, 65, 107, 114, 129. *P. m. gracilis*: A-11; C-73, 100, 102. *P. m. nebrascensis*: P-129. *P. m. nubiterrae*: C-52. *P. nuttali*: P-90. *P. truei* ssp.: P-134; C-64. *P. t. gilberti*: P-119, 129. *P. t. truei*: P-129, 133.

PHENACOMYS Merriam (voles).—*P. intermedius intermedius*: C-8.

PTYMYS McMurtrei (pine-mice).—*P. pinetorum* ssp.: C-21. *P. p. pinetorum*: C-128. *P. p. scalpoides*: C-38.

REITHRODONOTOMYS Giglioli (American harvest-mice).—*R. megalotis* ssp.: P-134; C-61.

SIGMODON Say and Ord (cotton-rats).—*S. hispidus* ssp.: P-133; C-44, 103, 110. *S. h. hispidus*: C-4, 5, 44, 61, 66, 82, 95, 103, 110, 117, 124. *S. h. littoralis*: P-130. *S. h. texianus*: C-61, 110.

SYNAPTOMYS Baird (bog-lemmings).—*S. cooperi* ssp.: C-90. *S. c. cooperi*: C-12.

GEOMYIDAE

GEOMYS Rafinesque (Eastern pocket-gophers).—*G. breviceps* ssp.: C-53, 73, 107. *G. b. breviceps*: C-73. *G. bursarius*: P-30, 86; C-4, 14, 15, 16, 37, 38, 42, 73, 89, 91. *G. personatus fallax*: C-73.

THOMOMYS Wied (Western pocket-gophers).—*T.* sp.: C-25. *T. bottae* ssp.: P-86, 90; C-64. *T. b. bottae*: C-20, 107. *T. fossor*: C-25. *T. talpoides* ssp.: C-61. *T. t. clusius*: C-33, 36. *T. t. tenellus*: C-4, 90.

HETEROMYIDAE

DIPODOMYS Gray (kangaroo-rats).—*D. agilis agilis*: P-46, 60, 114. *D. heermanni* ssp.: P-68; C-20. *D. h. morroensis*: P-46, 114. *D. m. merriami*: P-46, 60. *D. nitratoides brevinasus*: P-114. *D. panamintinus mohavensis*: P-33, 46. *D. p. panamintinus*: P-114. *D. spectabilis* ssp.: P-46. *D. venustus* ssp.: P-114; C-20.

PEROGNATHUS Wied (pocket-mice).—*P. californicus* ssp.: P-60, 75; C-20, 64. *P. formosus mohavensis*: P-114. *P. longimembris longimembris*: P-114. *P. parvus* ssp.: P-114.

MURIDAE

MUS Linnaeus (house-mice).—*M. musculus*: P-1, 2, 3, 4, 10, 15, 16, 47, 49, 64, 65, 78, 82, 83, 99, 106, 107, 109, 114, 115, 119; C-44, 45, 61, 67, 74, 76, 87, 88, 120, 124. *M. m. "albus"*: P-2, 10, 16, 17, 18, 28, 49, 65, 80, 107, 114, 115; C-44, 61, 63.

RATTUS G. Fischer (house-rats).—*R. norvegicus*: P-1, 2, 9, 10, 15, 16, 22, 32, 35, 47, 49, 50, 52, 53, 64, 65, 73, 74, 77, 78, 80, 81, 83, 88, 90, 91, 92, 93; A-3, 8, 9, 12; C-21, 40, 44, 57, 61, 63, 67, 68, 69, 77, 114, 115, 122, 124. *R. n. "albus"*: P-10, 13, 15, 47, 49, 52, 62, 63, 65, 67, 69, 74, 77, 78, 88, 106, 107, 109, 111, 114, 115, 116; A-3; C-44, 68. *R. rattus*: P-10, 41, 63, 73, 75, 83, 92, 107, 109, 114, 124; A-8, 12; C-21, 43, 44, 61, 66, 67, 87, 115, 120, 123, 124. "rat" (*R. norvegicus* ?): P-87, 88, 97, 106, 107, 109, 124; C-44, 61, 68.

SCIURIDAE

CITELLUS Oken (ground-squirrels).—*C. sp.*: P-133. *C. beecheyi* ssp.: P-12, 19, 23, 27, 51, 54, 56, 78, 98, 107, 127; C-60, 121, 128. *C. b. beecheyi*: P-12, 75, 78, 79, 84, 85; C-48. *C. beldingi beldingi*: P-12, 75, 78, 79, 85. *C. franklinii*: P-27, 29, 122. *C. lateralis* ssp.: P-20, 21; C-25. *C. l. bernardinus*: P-114. *C. l. chrysodeirus*: P-175, 85, 114. *C. parryi lyratus*: C-4. *C. richardsonii* ssp.: P-117; C-71, 101, 130. *C. townsendii*: C-127. *C. tridecemlineatus* ssp.: P-6, 12, 23, 51, 54, 78, 80, 94, 98, 108, 113, 123; A-7, 10; C-61, 101, 130. *C. t. tridecemlineatus*: P-12, 75, 79, 85; C-51, 61. *C. t. pallidus*: C-25. *C. t. texensis*: P-51, 78, 98, 107, 113. *C. variegatus buckleyi*: P-7.

CYNOMYS Rafinesque (prairie-dogs).—*C. sp.*: P-24, 101. *C. ludovicianus* ssp.: C-26, 38, 73.

EUTAMIAS Troussart (Western chipmunks).—*E. minimus jacksonii*: A-11.

GLAUCOMYS Thomas (flying-squirrels).—*G. sabrinus macrotis*: C-9, 19. *G. volans* ssp.: P-31, 42. *G. v. querceti*: A-7.

MARMOTA Blumenbach (woodchucks).—*M. caligata broweri*: C-22, 54. *M. c. caligata*: C-55. *M. flaviventris nosophora*: P-128; C-54. *M. monax* ssp.: P-11, 26, 38, 39, 48, 76, 90, 95, 100, 102, 104, 110. *M. m. monax*: P-34; C-41.

SCIURUS Linnaeus (tree-squirrels).—*S. sp.*: A-7; C-40. *S. carolinensis* ssp.: P-42; C-26, 84. *S. c. carolinensis*: A-7; C-24, 73, 124. *S. c. leucotus*: C-35. *S. griseus anthonyi*: P-14. *S. g. griseus*: P-44. *S. hudsonicus* ssp.: C-8. *S. niger* ssp.: A-1, 2, 5, 7, 12; C-29, 115. *S. n. bryanii*: P-14. *S. n. neglectus*: C-84, 115. *S. n. niger*: A-7. *S. n. rufiventer*: P-5, 14, 42, 44, 96; A-5, 11; C-19, 23, 27, 39, 44, 46, 50, 61, 73, 75, 84, 103, 120, 124.

TAMIAS Illiger (Eastern chipmunks).—*T. striatus* ssp.: A-5; C-61, 73, 127.

TAMIASCIURUS J. A. Allen (red-squirrels).—*T. sp.*: C-25. *T. hudsonicus* ssp.: C-8, 64. *T. h. ventorum*: C-8.

"SQUIRREL": A-4.

ZAPODIDAE

ZAPUS Coues (jumping-mice).—*Z. trinotatus* ssp.: P-134. *Z. princeps alleni*: P-132.

Contributions to the Life Cycles of Gorgoderid Trematodes

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The dearth of knowledge concerning life cycles and morphology of trematodes now placed in the subfamily Gorgoderinae Looss, family Gorgoderidae, led to a great deal of confusion concerning forms found in the urinary bladders of reptiles, amphibians, and fishes. Although studies in the last three decades have helped immensely in our understanding of these forms, a natural system is not evident. The difficulties appear to stem from: 1) incomplete knowledge of type specimens; 2) incomplete knowledge of excretory systems of many adult and larval stages; 3) apparent convergence of other characters used to classify adults; 4) lack of knowledge concerning morphology of larval stages and lack of carefully controlled experiments connecting them with specific adults; 5) either lack of stability in the excretory system or occurrence of an extremely ancient family which was once large and diverse, but in which now many intergradations are extinct.

Goodchild (1943) and Fischthal (1951) gave a rather complete survey of the literature, however, a brief account will be given below with basic information necessary to an understanding of this paper. Further historical material will be referred to in appropriate parts of this work.

Species of *Phyllodistomum* and *Catoptroides* occur in fishes and are probably closely related to forms described herein. Characters used to separate these genera have proved very confusing and will probably continue so until larval forms have been studied and interpreted. *Catoptroides* was erected on the basis of characters which many investigators have considered trivial and variable (Lewis, 1935). Characters which were used to differentiate it from *Phyllodistomum* are: vitellaria level to or posterior to the ovary, genital glands close to the acetabulum, testes placed symmetrically, or nearly so, and the posterior part a discoidal portion set off from the rest of the body by a definite groove. Although *Catoptroides* was placed in synonymy with *Phyllodistomum* by Nybelin (1926), Lewis (1935), Lynch (1936), and Bhalerao (1937) the genus has been supported by Loewen (1929) and Byrd, Venard, and Reiber (1940). Byrd *et al.*, in discussing the excretory system of the Gorgoderinae, as exemplified by *Phyllodistomum lobrenzi*, *Gorgodera attenuata*, *Gorgoderina tanneri*, and *Catoptroides lacustri*, concluded that "... the excretory system in the representative member [i.e., *C. lacustri*] of the genus convinces us that *Catoptroides* is more closely related to the genus *Gorgodera* than to the genus *Phyllodistomum*." Their work has, indeed, helped to eliminate some taxonomic uncertainty concerning this genus, but we have no assurance that the type species of *Catoptroides* possesses the type of excretory system described for *C. lacustri* by Byrd *et al.*, since it has been emphasized repeatedly, by several investigators, that characters by which we might choose a "representative member" may not be reliable in this case. It is not certain, therefore, whether Byrd *et al.* were dealing with *Catoptroides* or a new genus.

In the Gorgoderinae, life cycles of four species have been completed experi-

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mentally and conclusively (Krull 1935, Rankin 1939, Hunt 1952, and Goodchild 1943). Krull described the life cycle of *Gorgoderia amplicava* Looss, showing that the cercariae develop in *Musculium partumeium* Say, are eaten by *Helisoma antrosa* Say, and become metacercariae in this snail. The definitive hosts, *Rana clamitans* and *R. catesbeiana*, eat the snails. Goodchild (1948) added more details concerning this cycle. Rankin studied the life history of *Gorgoderina attenuata* Stafford, and found that stages which give rise to the cercariae are parasitic in the gills of *Sphaerium occidentale*, and that the large macrocercous cercariae are eaten by tadpoles, in which they encyst after penetrating the gut. Mature worms are found in *Rana* spp. and *Triturus v. viridescens*. *Phyllodistomum solidum* Rankin, parasitic in the urinary bladder of *Desmognathus fuscus fuscus* (Raf.), was observed by Goodchild (1943) to utilize *Pisidium abditum* Haldeman, as its first intermediate host, and that the cercariae were eaten by *Argia* sp., *Enallagma* sp., *Ischnura verticalis* and *Libellula* sp. (Odonata). Groves (1945) gave further details concerning the ecology and hosts of *Phyllodistomum solidum*. Hunt (1952) found that cercariae which develop in *Sphaerium simile*, encyst in *Sialis* spp. and *Cambarus* spp. and mature in *Rana clamitans*.

European workers have postulated several life cycles. Looss (1894), stated, on the basis of anatomical similarity, that *Cercaria macrocerca* v. Baer, found in *Anodontites cygnes*, *A. anatina*, and *A. cygnes ventricosa*, was the cercaria of *Distomum folium*. Lühe (1909) and Odhner (1911) concurred with Looss; however, Sinitsin (1901) stated that this was a mistake and that v. Baer's (1827) cercaria was another distome. Wagener (1857) stated that *Cercaria duplicata* developed into *Distomum tereticolle*, and Cosmovici (1891) believed that the larval form in the bivalve was that of *Distomum lanceolaum*. Nybelin speculated that *C. duplicata* developed into *P. elongatum*, on the basis of sucker ratios, position of the genital pore, and position of the genital primordium. He also thought that *C. duplicata* of Reuss might develop into *P. pseudofolium*. Lewis (1935), however, questioned the validity of *P. pseudofolium*.

There have been three general types of cercariae described for the Gorgoderinae: microcercariae, macrocercariae, and rhopalocercariae. These types can be differentiated mainly on the basis of the structure of the tail. According to Sinitsin (1901) the tail of the microcercaria degenerates at the time the caeca appear. Among the macrocercariae, there are forms which range from *Cercaria eriensis* Coil (1953), the tail of which is natatory and non-cystocercous, to those forms which are enclosed in an anterior tail chamber and in which the tail is not natatory *Gorgoderia amplicava* Looss (1899). The rhopalocercariae leave the bivalve and encyst shortly thereafter in their own tails which have become transformed. With the description of *C. eriensis*, there was established a new type of gorgoderid larva which had the combination of characters including a stylet, a second intermediate host, a parasite of the Unionidae, and a slender, natatory tail. The description of a single species might make it appear that this is an aberrant type, perhaps having little or no evolutionary significance. However, the description here of still another cercarial species of this type indicates that it is very unlikely that both of these cercariae are aberrant, thus it is more probable that *C. eriensis* represents an ancestral condition.

The macrocercariae are the largest and most diverse group of the gorgoderid cercariae. All of them appear to require a second intermediate host, and most of them develop in sphaeriid bivalves, except *C. mitocerca*, *C. eriensis*, and one to be described here, all of which develop in Unionidae.

There are both natatory and nonswimming forms. Most of the species possess tails with an anterior chamber into which the distome can partially or completely withdraw.

MATERIAL AND METHODS

Pelecypods were collected in large numbers from Lake Erie by means of a dredge. The inch wire mesh would not retain some species of clams nor the young of the ones reported here. The bivalves were placed in individual fingerbowls and examined daily for emerging cercaria with a dissecting scope over a period of three or four days. Infected clams were maintained alive in fingerbowls for several weeks, if provided with light and algae to supply oxygen. Ground spinach (prepared infant food) was fed with some success as indicated by the presence of feces one or two days after feeding starved clams. However, decomposition of the food with depletion of oxygen may have increased the mortality of the bivalves. In fingerbowls, the number of cercariae shed by a single clam decreased with time even though the water was changed frequently and algae were added.

Material to be sectioned was generally fixed in Sanfalice's fluid. Specimens for whole mounts were fixed in Sanfalice's, A.F.A., corrosive sublimate, Baker's formol, and Carnoy's fluid. Harris' hematoxylin was used exclusively for staining whole mounts, while Mallory's triple stain and Heidenhain's iron hematoxylin, destained with picric acid, were used for staining sections. The worms were relaxed by the use of heat, chloretone or shaking. Heating seemed to give the most complete relaxation.

All measurements are in millimeters.

The bulk of this study was carried out at Stone Institute of The Ohio State University.

ACKNOWLEDGMENTS

The author is indebted to Dr. E. W. Price for checking the availability of the specific name and for the loan of an English translation of Sinitsin's (1905) paper. Thanks are due The Ohio Division of Wildlife and Mr. E. Miller, Superintendent of the Ohio State Hatchery, for the use of certain facilities. The study was financed by the Ohio Division of Wildlife.

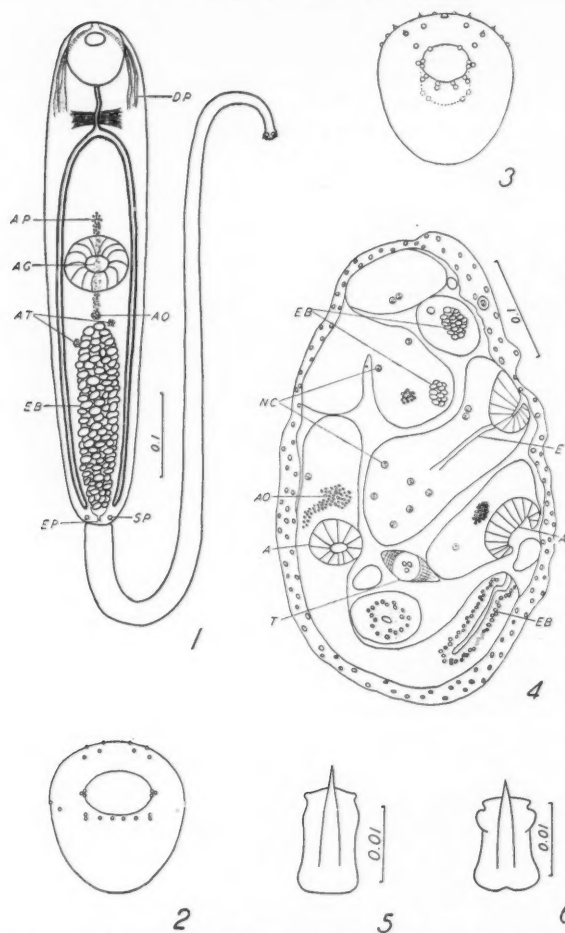
OBSERVATIONS

Mussels to be examined for emerging cercariae were collected from Lake Erie in depths ranging from twenty to thirty-five feet. Subsequent examination led to the discovery of a gorgoderid cercaria, which was determined to be an unnamed macrocercaria closely related to *C. eriensis*. The host, *Lampsilis siliquoidea*, frequents mud bottoms and comprises about 85 percent of the pelecypod population in that habitat.

Cercaria lampsilae sp. nov.

Figs. 1, 3, 4, 6

Specific diagnosis.—Apharyngeate, styled cercaria with the characters of the subfamily Gorgoderinae Looss, 1899. Body measurements of ten specimens fixed in warm A.F.A. cleared in glycerine and mounted in glycerine jelly (all cercariae had emerged



Figs. 1-6.—1. Composite drawing of *C. lampsilae* drawn from information gained from sections, living specimens, and stained whole mounts; 2-3. Sketch of arrangement of sensory papillae on the oral sucker. 2. *C. eriensis*; 3. *C. lampsilae*; 4. Section of daughter sporocyst of *C. lampsilae* drawn with the aid of a microprojector; 5-6. Stylet drawn with the aid of a camera lucida. 5. *C. eriensis*; 6. *C. lampsilae*.

from the host and were swimming actively when captured), are: body length 0.625 (0.504-0.904), width at posterior end 0.07 (0.06-0.08), width of oral sucker 0.072 (0.067-0.09), width of anterior end 0.09 (0.083-0.115), width of acetabulum 0.078 (0.073-0.083), width of body at acetabulum 0.1 (0.076-0.112), distance between acetabulum and oral sucker 0.215 (0.147-0.332), length of esophagus 0.053 (0.012-0.09), distance between acetabulum and posterior end 0.309 (0.144-0.505), distance between anterior end of bladder and acetabulum 0.035 (0.022-0.083), length of bladder

0.274 (0.118-0.426), width of bladder 0.057 (0.044-0.064), length of stylet 0.018 (0.016-0.019), excretory bladder surrounded by large, ellipsoidal, mononuclear, unicellular, cystogenous glands containing a substance which appears hyaline when alive but finely granular when fixed. Nuclei of glands large with prominent, eccentric nucleoli. Contents of glands stain erratically with eosin. Other glands, pyriform, and unicellular, also interpreted as cystogenous glands, found throughout much of body. These glands open to the exterior by means of a small duct on the ventral side and possess a large nucleus with prominent nucleolus. Living cytoplasm hyaline, staining with neutral red. Fixed cytoplasm stains with eosin, thionin blue, toluidine blue and orange G. Bifurcate intestine extending to posterior region of body. Esophagus muscular. Bilobed "brain" dorsal to esophagus. Slender, tubular bladder extending to region of genital fundaments. Complete excretory system not visible in cercaria. Suckers well developed and active. Details of penetration glands not obvious in cercaria, but four ducts were counted. Glands located just anterior to acetabulum, and ducts follow a slightly lateral course to the posterior of oral sucker. Enlarged ducts serve as reservoirs for the glandular contents of the glands. Glands open to exterior by minute pores lateral to stylet. The contents stain with eosin, Nile blue sulphate and neutral red. Nuclei present which are similar to those found in other unicellular glands in this worm. Testes differentiated and present as clumps of cells on opposite sides of the bladder. Fundaments of ovary and vitellaria located at end of excretory bladder. The primordia of the genital ducts present as a heavy strand of cells dorsal to acetabulum. Terminal genitalia not differentiated, but primordia are present as a clump of cells. Sensory papillae on oral sucker, acetabulum, and body surfaces in characteristic pattern. Some papillae with a seta. Stylet small, complex with lateral wings and slender point. One to six cercariae develop in ellipsoidal sporocysts. Birth pore present in daughter sporocysts.

Host: *Lampsilis siliquoides*.

Locality: Lake Erie, Ottawa County, Ohio.

Paratypes: Helminthological collection, USNM No. 48708.

Cercaria lampsilae differs from *C. eriensis*, its closest relative, by possessing 1) a stylet which is slightly shorter and of a different shape, 2) a different disposition of sensory papillae on the oral sucker, 3) a body length which is shorter.

In the visceral mass of the host, mainly among the gonads, the daughter sporocysts are found in large numbers (fig. 4). Living sporocysts are cream-colored, egg-shaped, and virtually non-motile, although the wall is frequently distended and distorted by the action of the cercariae. Tissues of the host are not incorporated in the wall of the sporocyst. In very young sporocysts, the birth pore is readily observed. The birth canal is directed at a slight angle from the longitudinal axis, and opens to the surface subterminally. The diameter of the canal is greatly reduced at the distal end of the birth canal, where there is a sphincter muscle. The lining of the canal is heavier than the external cuticle, and it is abundantly crinkled from the region of the sphincter, with the amplitude of irregularities varying directly as the distance from the birth pore. Numerous small nuclei are associated with the wall of the canal. They consist of a heavy nuclear membrane, one or more large nucleoli, and several large particles of chromatin.

The external cuticle surrounding the birth pore is approximately twice as heavy as that at the opposite end of the sporocyst. It is overlaid with a closely papillated coating which appears amorphous internally. This coating stains much less readily with eosin than does the cuticle, and it extends, with progressively decreasing thickness, about one-fourth of the way around the sporocyst from the pore. The internal lining of the sporocyst, which is relatively thin, appears amorphous and stains with eosin in a manner similar

to that of the external cuticle. The body wall is thick (0.058 mm.) at the attenuated end and about one-third as thick at the opposite end. This wall is composed of two limiting membranes and a parenchyma in which one finds two types of nuclei. One type lies free in the parenchyma and does not appear to be associated with any specific cytoplasm. An eccentric nucleolus lies beside the nuclear membrane, very few chromatin particles are present, and the nuclear membrane is relatively heavy. The other type is surrounded by an envelope of cytoplasm which appears amorphous and stains with eosin.

EXPERIMENTS WITH THE CERCARIAE

Clams collected from Lake Erie were placed on bottom of a large wooden tank (428x59x78 cm.) through which lake water, at a temperature 1 or 2 degrees warmer than that of the lake, passed at a rate of about 10 liters a minute. The tank contained representatives of all species of clams which had been collected and which had been examined previously for emerging cercariae. The water was rich in oxygen, and contained many diatoms and copepods. The clams were frequently fed phytoplankton taken from the lake with a No. 25 plankton net.

Examinations subsequent to the death of some of the clams revealed the presence of two species of gorgoderid trematodes encysted in the viscera. At the time specimens of *Cercaria lampsilae* and *C. eriensis* were found, several organisms were investigated as possible second intermediate hosts. Clams of several species had been placed in fingerbowls and exposed to these cercariae, but encystment did not occur. However, the presence of hundreds (300 in one case) of cysts in infected clams from the experimental tank, as compared with specimens possessing natural infections numbering at the maximum, 10, convinced the author that the metacercariae in the experimental clams could have resulted only from cercariae which had been present in the tank.

In order to determine conclusively the second intermediate hosts of these cercariae and to demonstrate that *C. eriensis* and *C. lampsilae* give rise to specific metacercariae clams harboring infections of these cercariae, were placed in wooden tubs provided with coarse sand three to four cm. deep, and lake water running at the rate of about one liter a minute. The food supply was supplemented as above. It is well known that pelecypods do not feed properly under many laboratory conditions and are easily disturbed.

In one tub, mussels infected with *C. eriensis* were placed with specimens of *Lampsilis ventricosa*, *Ligumia recta*, *L. nasuta*, *Elliptio dilatatus* and *Amblema costata*. In two other tubs, *Lampsilis siliquioidea* infected with *Cercaria lampsilae*, were placed with several other clams of the same species. A fourth tub was used as a control to determine whether the cercariae had been carried in by the supply of lake water.

Subsequent examinations of the clams proved that the two cercariae involved in the experiment gave rise to the two metacercariae described below. The evidence supporting this conclusion is 1) the age of the metacercariae (i.e., younger than any natural infection which might have been in the clams at the start of the experiment), 2) the shape and the size of the stylet found in the cystic fluid corresponded with that of the cercaria, 3) the second intermediate hosts contained metacercariae of only one species.

It should be noted here that the encysted worms were removed by tearing the clam tissue; however, after this was accomplished, the macerated tissue was subjected to pepsin digestion. This left the worms dead, but the cysts apparently intact. By this method, it could be determined that the mechanical method of removal, even with the most painstaking care, missed 10 to 25 percent of the cysts present, depending on the number present originally.

The cercarial stage is drawn into the mussel through the incurrent siphon, and presumably, penetrates the intestine entering the visceral mass where it encysts. A thin, delicate cyst is formed within one week after penetration. It was not determined, with certainty, which cystogenous glands give rise to the initial cyst, but sections of the metacercariae did not reveal the cystogenous glands scattered through the body, while observations on living material showed that the gland cells around the bladder were very slow to deteriorate. The cercarial stylet was seen lying free in the cystic fluid, and the gap which it leaves is readily observed in the living metacercaria.

The worm develops greatly during its life as a metacercaria. The time required for the level of development displayed by large metacercariae is four to six months at temperatures which occur in the lake over the course of the winter. Although the body length may increase fourfold, sexual maturity is not attained. With the increase in size, there is a decrease in motility and a deterioration of the sensory papillae. When excysted mechanically, the trematodes show only slight motility and when placed in saline, they show little more. The most evident change is in the reproductive system which completely differentiates.

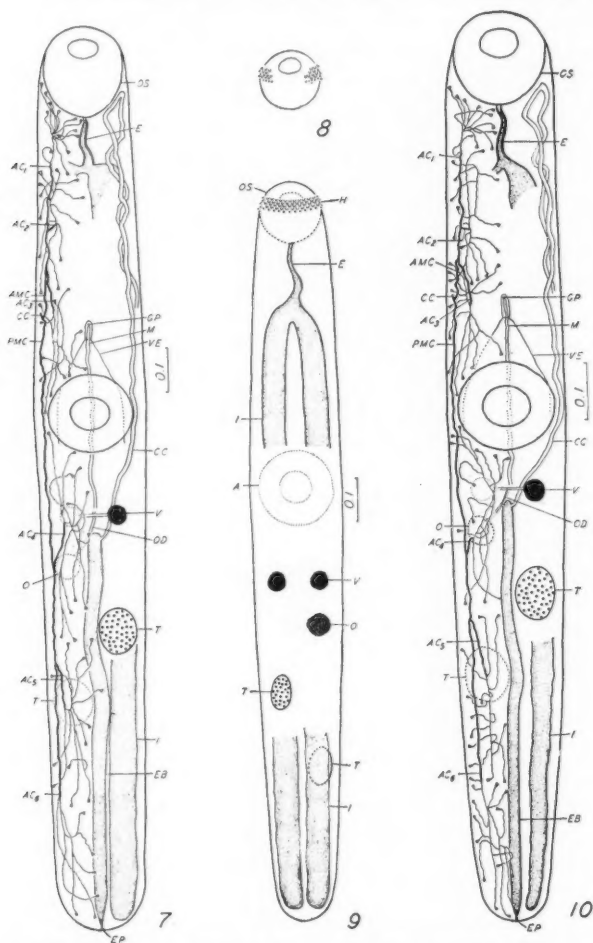
METACERCARIA OF *CERCARIA LAMPILAE*

Fig. 10

The body measurements of ten specimens of *C. lampilae* fixed in warm A.F.A. and cleared in glycerine are: width of oral sucker 0.144 (0.125-0.167), width of acetabulum 0.174 (0.139-0.195), diameter of esophagus 0.012 (0.007-0.018), diameter of intestine just posterior to the bifurcation 0.031 (0.018-0.044), diameter of intestine at the level of the acetabulum 0.023 (0.017-0.032), diameter of intestine at posterior end 0.02 (0.010-0.024), encysted metacercariae 0.341x0.458 (0.32-0.382x0.396-0.513), anterior testis 0.04x0.049 (0.026-0.055x0.032-0.271), posterior testis 0.043x0.052 (0.026-0.066x0.035-0.08), right vitellarium 0.027x0.04 (0.017-0.048x0.024-0.058), left vitellarium 0.025x0.037 (0.021-0.034x0.024-0.046), ovary 0.035x0.04 (0.024-0.048x0.027-0.049), length of body 1.934 (1.434-2.113), width of anterior end at level of oral sucker 0.167 (0.146-0.188), width at level of acetabulum 0.216 (0.181-0.243), width at posterior end 0.104 (0.083-0.125), distance between oral sucker and acetabulum 0.897 (0.486-0.992), distance between testis and posterior end 0.389 (0.292-0.424), distance between testis and posterior end 0.506 (0.382-0.603), distance between ovary and posterior end 0.624 (0.472-0.762). The cells of the cystogenous glands surrounding the bladder appear shrunken and irregular and tend to disappear as the worm develops until only the slender, thin-walled bladder remains. After a month or two, the glands become free in the bladder and will pass out through the excretory pore when pressure is applied. The cyst itself is 0.010 mm. thick, amorphous, and so hyaline that many observations on the anatomy of the trematode can be made through the cyst. Vital stains diffuse through the cyst easily.

The bladder is a simple, tubular organ reaching to the level of the ovary. In a six month old metacercaria, the bladder is very slender, possessing no diverticula and no cystogenous cells. During the course of development, the excretory pore becomes less subterminal and opens to the exterior by means of a small pore and short duct. This pore opens into a shallow crater which is directed toward the posterior of the worms. A

short distance subterminal to the anterior end of the bladder the common collecting ducts arise and follow an undulating course in an anterior-lateral fashion to the level of the acetabulum. From this point to a point opposite to the posterior third of the oral sucker, the ducts follow a shallowly undulating course along the lateral margin of the worm. They reflex posteriorly in the region lateral to the oral sucker, and give rise to



Figs. 7-10.—Composite drawing of the metacercaria of *Cercaria eriensis* drawn with information gained from sections, whole mounts, and living specimens; 8. Drawing of the spination of *Metacercaria quadraspinis* from the ventral aspect; 9. Composite drawing of *Metacercaria quadraspinis* drawn from two flattened, stained, whole mounts; 10. Composite drawing of the metacercaria of *Cercaria lampilae* drawn with information gained from sections, whole mounts, and living specimens.

the main collecting ducts (anterior and posterior) at a point slightly anterior to the genital pore.

The main collecting ducts each give rise to three accessory collecting ducts. The accessory collecting ducts in turn divide into capillaries which terminate in flame cells. The first group, which contains 11 flame cells, is posterior and lateral to the oral sucker and lateral to the esophagus. The second group, containing 14 flame cells, extends, roughly, from the bifurcation of the intestine to the region anterior to the stylet and course. The third and fourth groups are in the region between the anterior testis and genital pore. The fifth group extends slightly anterior and posterior to the posterior testis, and the sixth group occupies the posterior region. The exact division of the capillaries was not constant, but the relative position of the flame cells appeared to be so. The flame cell formula is: $2[(11+14+12)+(12+12+14)]$.

The penetration glands of *C. lampsilae* persist for some time after encystment. They were still present in worms known to be encysted for four months. Finally all evidence of the glands disappears, except for the remnants of the ducts just posterior to the oral sucker. The details of the glands could not be determined from the cercaria, but will be discussed here. The ducts terminate in minute pores lateral to the stylet and course dorsally over and through the oral sucker, distending rapidly as they pass posteriorly. In the cercaria, the ducts are greatly distended with cystogenous material just posterior to the oral sucker. This is not the case with the metacercaria, in which the ducts appear to be almost uniform in diameter from the region of the esophagus to the gland cell. The stage of the metacercaria in which the glands are well formed and clearly visible was not found in this species as it was in *C. eriensis*.

The reproductive system is differentiated into all the component parts which are found in adult gorgoderid distomes. None of the glands appear lobed at this stage; all of them are rounded and almost spherical in the living specimen.

The rate of development is rapid after encystment, the maximum rate of development being noted within six weeks after encystment. The development of gametes remains at a low level; neither sperm nor ova were observed.

The sensory papillae change after the encystment, some of those on the oral sucker becoming enlarged and changed in general appearance. The differential development of these papillae gives the appearance of a different arrangement of them at this stage.

In the metacercaria of *C. lampsilae*, the cuticle dorsal and lateral to the oral sucker becomes relatively slightly roughened. At the posterior end, several cuticular processes develop in the region of the excretory pore. The roughening over the oral sucker is much more evident in the other two metacercaria described here.

Specimens have been deposited with the USNM Helminthological Collection, No. 48755.

METACERCARIA OF CERCARIA ERIENSIS

Fig. 7

C. eriensis encyst in several clams, but most often in *Ligumia nasuta*. Other clams in which cysts were found are *Lampsilis siliquoides*, *L. ventricosa*, *Amblema costata*, *Ligumia recta*, and *Elliptio dilatatus*.

Superficially the cysts can be differentiated from those of *C. lampsilae* by size. The cyst of *C. eriensis* is larger and the distome is much more crowded in it, leaving no visible space. Indeed, the worm is folded to such an extent that it is some time after mechanical excystment before the organism can stretch out its folds.

Other structures characterize this trematode from the one previously described. Dorsal and lateral to the oral sucker are cuticular roughenings which are much more pronounced than the small ones found in the metacercaria of *C. lampsilae*. The cuticular processes found at the posterior end of the body in the region of the excretory pore are very similar in both species. The most apparent difference in the excretory systems is that the most posterior accessory tubule gives rise to only six capillaries in *C. eriensis*, while in *C. lampsilae* there are 14 flame cells in the most posterior group. The flame cell formula is $2[(12+12+12)+(12+12+6)]$.

The body measurements of ten metacercariae of *C. eriensis*, excysted, relaxed by shaking, fixed in glycerine alcohol, mounted in glycerine jelly are: length of body 2.15 (1.98-2.52), width of oral sucker 0.169 (0.158-0.195), width of anterior end 0.198 (0.195-0.312), esophageal length 0.108 (0.078-0.179), diameter of intestine just posterior to the bifurcation 0.089 (0.065-0.13), diameter of intestine at level of acetabulum 0.067 (0.039-

0.09), width of acetabulum 0.199 (0.169-0.221), width of body at the level of the acetabulum 0.245 (0.195-0.26), right vitellarium 0.039x0.045 (0.03-0.057x0.033-0.072), left vitellarium 0.043x0.044 (0.021-0.069x0.03-0.057), ovary 0.055x0.069 (0.047-0.087x0.047-0.075), anterior testis 0.093x0.113 (0.075-0.132x0.74-0.145), posterior testis 0.098x0.116 (0.087-0.123x0.127-0.156), length of excretory bladder 1.01 (0.895-1.22), width of excretory bladder 0.042 (0.039-0.051), width of posterior end of body 0.206 (0.117-0.246), diameter of intestine at the posterior end 0.079 (0.039-0.117), distance between acetabulum and genital pore 0.085 (0.052-0.130), distance between oral sucker and acetabulum 0.558 (0.416-0.689), distance between acetabulum and vitellaria 0.166 (0.130-0.260), distance between acetabulum and ovary 0.230 (0.182-0.403), distance between acetabulum and anterior testis 0.336 (0.273-0.403), distance between acetabulum and posterior testis 0.512 (0.376-0.599), distance between acetabulum and posterior end 1.24 (1.12-1.42).

In describing *C. eriensis*, the description of the penetration glands was in error. The glands do not lie just posterior to the oral sucker, as depicted, but rather just anterior to the acetabulum. This is not apparent in the cercaria but can be observed in metacercariae of the proper age. The number of glands appears to increase as the metacercaria develops. Only four ducts were noted in the cercaria, but twelve fully developed glands were counted in the metacercariae.

Specimens deposited in the USNM Helminthological Collection, No. 48710.

METACERCARIA QUADRASPINIS

Figs. 8 and 9

Only two specimens were found encysted in *Ligumia nasuta*. Superficially, this form is readily differentiated from the other metacercariae described here by the almost spherical cyst into which the distome is crowded. The most outstanding feature of this gorgoderid trematode is the possession of four rows of large spines and one row of small spines dorsal to the oral sucker. The individual spine or hook appears square from the frontal aspect and almost deltoid from the lateral aspect. No detail of the excretory system could be determined from the living worm; however, the similarity between this specimen (other than the spines) and the two others described here leads the author to believe that they are closely related, perhaps belonging to the same genus.

Body measurements from two specimens flattened with considerable coverglass pressure, fixed with Sanfalice's fixative, and mounted in damar are: width of oral sucker 0.145 (0.144-0.148), width of anterior end at level of oral sucker 0.178 (0.176-0.18), distance between oral sucker and acetabulum 1.77 (1.59-1.96), width at level of acetabulum 0.226 (0.202-0.246), width of acetabulum 0.177 (0.159-0.196), diameter of intestine just posterior to bifurcation (one specimen) 0.054, diameter of intestine at level of acetabulum 0.051 (0.045-0.057), diameter of intestine at posterior end 0.058 (0.057-0.06), width of posterior end 0.121 (0.105-0.136), distance between acetabulum and vitellaria 0.277 (0.256-0.3), distance between acetabulum and ovary 0.451 (0.309-0.606), distance between acetabulum and anterior testis 0.450 (0.441-0.465), distance between acetabulum and posterior testis 0.825 (0.616-0.631), right vitellarium 0.03x0.049 (0.027-0.033x0.049), left vitellarium 0.024x0.054 (0.021-0.027x0.048-0.06), ovary 0.047x0.056 (0.03-0.055x0.045-0.066), anterior testis 0.052x0.099 (0.039-0.066x0.099), posterior testis 0.051x0.012 (0.047-0.054x0.011-0.012), length of esophagus 0.195 (0.180-0.21), length of body 2.3 (2.148-2.47).

The presence of spines is considered to be a primitive character and *Metacercaria quadraspinis* is considered to be more primitive than either *C. eriensis* or *C. lampisilae*. It is interesting to note that there is a progressive reduction of anterior cuticular processes from the specimen at hand through *C. eriensis* and *C. lampisilae*. In the last-mentioned form, they are greatly reduced. It is predicted that this species has a cercaria similar to *C. eriensis* and *C. lampisilae* and either without spines or with reduced spines.

Specimen deposited in the USNM Helminthological Collection, No. 48711.

GORGODERID METACERCARIAE

Since encystment occurs in the tail shortly after the cercariae leave the mollusc, in the case of the rhopalocercariae, the metacercariae of this group

change little in this short time, and their description follows very closely to that of the cercaria. Metacercariae have been described for *Phyllodistomum solidum*, *Gorgoderina attenuata*, *Gorgoderia amplicava*, and those forms described by Sinitsin (1905). *Phyllodistomum lesteri* Wu (1938), is progenetic, and therefore must be considered as possessing characters of an adult worm even though it is still in a metacercarial cyst.

In most instances, the gorgoderid cercariae are taken into the body of the second intermediate host passively rather than by active penetration of external tissues. However, penetration takes place, rather, through the intestine or esophagus in the case of the aquatic insects utilized as second intermediate hosts. Where clams are utilized as hosts, the cercariae are drawn into the incurrent siphon with water, and they presumably penetrate through the alimentary tract and encyst in the viscera. In other species which encyst in clams (allocreadiids), penetration generally takes place through the tissue of the foot where the path of lysis can be seen. It is apparent that when cercariae utilize snails for their second intermediate hosts, the snail ingests the cercaria along with bottom debris. The motility of the macrocercariae which encyst in insects may exhibit a certain amount of mimicry to the motility of larval insects which are preyed upon by the second intermediate host. This mechanism may be only crudely developed; the cercaria are frequently destroyed by mastication and are later digested.

The cyst is elaborated successively in *C. eriensis*, *C. lampsilae*, and *C. phyllodistomum solidum*. Goodchild (1943) reported that the stylet was shed, and, after it had dropped to the bottom of the cyst, more cyst material was elaborated, thus the stylet was surrounded by cyst material. Sinitsin (1905) reported the same phenomenon in the cercariae studied by him.

The production of the cyst material has been reported mainly from the cystogenous glands which surround the bladder. Sinitsin (1905) described the cells of the bladder as tall, columnar epithelium, and he suggested that they are concerned with the formation of the cyst. Since the reduction of these cells is slow after encystment, Vickers (1940) was not certain that they are cystogenous glands. He suggests that these cells have an excretory function. Sinitsin (1905) described bodies in the bladder which developed from the large cells and which were amoeboid in motion. Vickers (1940) described what he thought might be true cystogenous glands, in the anterior part of the body, while Goodchild (1943) suggested that these glands might be the source of the secondary cystogenous material. Glands similar to the glands surrounding the bladder, but located throughout the body of the cercaria, have been described for *C. eriensis* and have been found in *C. lampsilae*, *C. anodontae*, and *C. pyriformoides*.

The rates of development (after encystment), which have been reported, vary considerably. Sinitsin (1905) describes the growth as rapid in the metacercaria. Goodchild (1943) reports that little actual development takes place during the metacercarial stage with *Phyllodistomum solidum*. With *Gorgoderina attenuata* a slight amount of development of the reproductive system takes place, while Krull (1935) reports that in this respect, the cercaria and metacercaria are very similar. In all cases the sensory papillae appear to change in structure after encystment.

The penetration glands become reduced with time at varying rates. In the

metacercariae of *C. eriensis*, *C. lampsilae*, and *G. amplicava*, they are prominent and numerous after encystment.

DISCUSSION

Cercaria eriensis was described as the first primitive cercaria of its type for the Gorgoderinae. This statement was based on the fact that this cercaria possessed characters found in all the diverging groups of gorgoderid cercariae. The description of still another cercaria of this kind (*C. lampsilae*) establishes more firmly this sort of cercaria, avoiding somewhat the condition of *artenarme Gattungen* so lamented by Looss. The occurrence of a metacercaria with hooks gives evidence of another cercaria which, possibly, is close to the ancestral stem of *C. lampsilae* and *C. eriensis*. Some of the remaining known gorgoderid cercariae have become specialized in their life histories and morphology so they are less like the larvae of other trematodes which are most frequently pelagic. The types of specialization are seen in the cercariae of *Phyllodistomum folium*, a microcercaria which possesses only a rudiment of a tail and encysts in its sporocysts and the rhopalocercariae which encyst in their transformed tails.

In view of the fact that the gorgoderid cercariae have become specialized along rather sharply delimited lines, which coincide with the host families of pelecypods, it seems very probable that these cercariae have evolved along with the diverging families of bivalves. Fischthal, 1951, quotes A. A. Rehder as saying: "(1) in general, these three families [Sphaeriidae, Unionidae, and Dreissenidae] represent absolutely independent development and/or invasions into freshwater from separate biologic stock. (2) The Sphaeriids and Dreissenids are a little closer to each other than either is to the Unionids."

Before any further discussion of relationships is undertaken, some comparisons of the morphological differences among the gorgoderid cercariae will be undertaken with particular emphasis on the evidently more primitive *C. eriensis* and *C. lampsilae*.

All gorgoderids possess many features in common; however, they do vary in respect to the tail, the presence of a stylet, and the excretory system. These characters may be of considerable systematic value. Indeed, Faust (1932) suggested that the variations in the excretory systems indicate that here several families have been classified as one, and Byrd *et al* (1940) suggested that it would be necessary to erect other categories to separate the diverse individuals now included in this subfamily. It is also quite possible that some misinterpretation of the excretory systems has occurred.

Probably the most common type of excretory system which occurs in this subfamily is of the stenostoma type which Byrd *et al* (1940) described as characteristic of the *Gorgodera-Catoptroides* group. In this case, the primary collecting ducts arise from the bladder subterminally, course to the region of the intestinal bifurcation where they reflex posteriorly, and in the region of the genital pore, they branch into secondary collecting ducts. A system of this type has been reported to occur in *Phyllodistomum patellare*, *Gorgodera amplicava*, *Cercaria sphaerocerca*, *P. brevicacum*, *P. undulans*, *Catoptroides lacustri*, *P. semotili*, *P. notropidus*, *P. nocomis*, *P. solidum*, *Cercaria donecercera*, *Cercaria coelocerca*, five additional rhopalocercariae described by Fischthal (1951) *C. anodontae*, and *C. pyriformoides*.

According to Miller (1935) the excretory system of *C. mitocerca* consists of a primary collecting duct which "... divides anteriorly to form the two main collecting tubules which, in the anterior region of the body, turn posteriorly and run the entire length of the body again. This bladder and the main collecting tubules resemble greatly those of *C. sphaerocerca*." The drawings by Miller (1935) show no great similarity between the main collecting tubules of the two forms; however, Fischthal (1951) interpreted the excretory system of *C. mitocerca* as a transition between forms in which the bifurcation occurs anterior to the acetabulum and those in which it occurs posterior to that structure.

C. eriensis and *C. lampsilae* possess the stenostoma type of excretory system which is very similar to that described for *C. pyriformoides*. They all possess 3 flame-cell groups in each quadrat and a common collecting duct which reflexes in the region of the esophagus or lateral to the oral sucker.

Byrd *et al* (1940) described the mesostoma type of excretory system as characteristic for the *Gorgoderina-Phyllodistomum* group. Here the bifurcation of the main collecting ducts occur a short distance from the bladder in the region of the acetabulum, slightly anterior to it. In the case of the forms of this type, figured by Byrd *et al* (1940) (*Phyllodistomum lohrenzi* Loewen and *Gorgoderina tanneri* Olsen) both have four accessory collecting ducts in each quadrat, making a total of 8 pairs in the entire worm. The primary ducts connect terminally with the bladder. Looss (1894) determined the excretory system for *Phyllodistomum cygnoides* to be $6 \times 12 \times 2 = 144$.

The tails of the gorgoderid cercariae show great diversity of structure. *C. Phyllodistomum folium*, a microcercaria, is described by Sinitsin (1901) as having a short, stumpy tail which becomes vestigial at the time of the development of the bifurcation of the gut. However, only one species of this type has been described.

As a group, the rhopalocercaria appear to possess tails which are all very similar in nature. When the cercariae reach fresh water, after leaving the host, the highly plaited tails distend rapidly, and the distome is withdrawn into the cercarial cavity in which it encysts shortly thereafter. In some instances, the tails are very similar in shape. In both *C. pyriformoides* and *C. pyriformis*, the tail assumes a pyriform shape when distended. According to Fischthal (1951) *C. filicauda* has a "... posterior division which consists of an elongate, adhesive, structureless, threadlike filament of cuticle. ..." This is the only rhopalocercaria with a *two-part tail*, and such a tail probably is comparable to the posterior appendage of the tail in certain macrocercaria.

From the point of view of both the tail and the excretory system, the macrocercariae are a very diverse group. The macrocercous species *C. eriensis* and *C. lampsilae*, parasitic in unionids, have a noncysticercous, motile tail and can maintain themselves suspended in the water for several hours. In these species, the tail is characteristically provided with papillae on the tip; however, the tails are not adhesive. Other macrocercous species which possess a natatory tail, but of the cysticercous type, are *C. raiaicauda* Steelman (1938) and *C. stellmani* Baker (1943). The former readily swims for some time, and can withdraw completely into a chamber in the proximal part of the tail. The latter species is enclosed in the cercarial chamber while active, but leaves it upon becoming moribund. Both species have large lateral distension on the tail

just posterior to and including the cercarial chamber. *C. coelocerca* and the cercaria of *Gorgoderina amplicava* possess motile, nonnatatory tails with a distal portion which is adhesive. The sticky nature of the tail in the latter species would appear to be an aid in gaining entry into the second intermediate host, which is a snail. Both of these marocercous forms readily withdraw completely into an anterior chamber in the tail. Posterior to the distension, the tails are long and filamentous. *C. mitocerca* has a long filamentous tail which is virtually non-motile.

According to Rankin (1939) the tail of *Gorgoderina attenuata* is hardly distinguishable from that of *Gorgoderina amplicava*. They are provided with a cercarial chamber and appear to be almost structureless. *Cercaria donecercia* swims in loose spirals. It is also capable of attachment or flotation. This cercaria becomes completely enclosed in the anterior chamber. Vickers (1940) described the tail of *C. macrocerca* as possessing minute spines distally, and as being able to form a sucker. This has been noted recently by the author in an undescribed macrocercaria. Cells, perhaps mucoid, were reported at the posterior end of the tail by Vickers. The cercariae named by Sinitsin (1905) possess similar tails which are about 10 times the length of the body and are swollen proximally. The cercarial body is contained in a proximal chamber of the tail. The distal portion, however, is considerably shorter than this part of the tail in other similar cercariae.

EVOLUTION IN THE GORGODERID CERCARIAE

Ideally, one should be able to indicate the phylogeny of a group by the interpretation of several structures, in various forms, which occur throughout the group. Extinction of intergradations has complicated the problem and apparent genetic stability has left little basis by which to interpret evolution. The only apparent structures which can be utilized to show phylogeny in these cercariae are the excretory systems and the nature of the tails. Body size, number of penetration glands and sensory papillae are characters which are valuable to separate species, but they are difficult to interpret in terms of phylogeny.

There are four types of tails in this subfamily, namely cystocercous, microcercous, rhopalocercous, and the natatory, filamentous type which is more similar to the tails of other trematodes. It is evident that here the tail is a caenogenetic structure and is of value to indicate categories of relatively recent origin. We are interested in the relative evolution of the forms in this group; therefore, except for the main stem in comparison with other families of trematodes, the rate of evolution or the time of origin are of no great import. This evidence, if available, might change the higher categories, but not necessarily, since the characters used for their delineation are largely arbitrary and not necessarily constant.

The unknown ancestor of the gorgoderid cercariae assumed by Fischthal (1951) has not been described; however, his prediction of a primitive natatory, macrocercous cercariae possessing a stylet has been well established by the description of *C. lampsilae* and *C. eriensis*. These cercariae are considered the most primitive ancestors of the gorgoderid cercariae not only on the basis of possession of characters common to the diverging groups of cercariae, but also by their being less modified, they are more like the larvae of other tre-

matode groups. *C. lampsilae* and *C. eriensis* are the only styleted forms reported which parasitize the Unionidae. In these two species the tail is completely natatory and lacks an anterior chamber into which the body of the distome could withdraw or encyst. Therefore, this type of tail is considered to be less specialized than the other types of tails in this subfamily. The excretory system is of the stenostoma type, but the primary tubules reflex laterally to the oral sucker rather than in the region of the bifurcation of the intestine, and there are only 6 pairs of accessory collecting tubules. In other respects the body is typically gorgoderid and appears to be most closely related to the rhopalocercariae. Further and conclusive evidence of the gorgoderid affinities of these cercariae is the type of reproductive system which develops to a level which can be recognized in the metacercariae.

Concerning the age of the host family which harbors these cercariae, to the Cretaceous period, while the family Dreissenidae is first found in the Fischthal (1951) quotes A. A. Rehder: "The family Sphaeriidae goes back Tertiary. The Unionidae is, of course, much older, going back to the Triassic, and probably beyond that, although the question of ancestry of these fresh water mussels is still a disputed one. Some workers claim that the Unionidae go back to the Devonian."

C. mitocerca, slightly more specialized than the two species above, is considered an intermediate species, allied to the rhopalocercariae by the 1) possession of sporocysts which develop in the viscera of a unionid host, and similarity to the rhopalocercariae in regard to cystogenous glands, the excretory system and absence of a stylet. The level of development of the reproductive system of *C. mitocerca* also is intermediate between that found in *C. eriensis* and that in the rhopalocercariae. In the former, the lobate testes, still in the stage of a clump of cells, are the only organs differentiated, while in the rhopalocercariae, all of the component parts are differentiated. The tail is similar to that found in *C. sphaerocerca*, consisting of a proximal chamber, a middle swollen portion, and a distal filamentous part. The possession of a cercarial chamber may indicate a relationship to the macrocercariae found in sphaeriids. It can be postulated that *C. mitocerca* originated from a more recent stem than that which gave rise to *C. eriensis* and to *C. lampsilae*. Although it is equally possible that this type of tail could have arisen independently, the intermediate status of this form is established by the host and other structures. Fischthal (1951) noted that the distal filamentous portion of the tail is similar to that found in *C. filicauda*.

The evolution of the rhopalocercariae as a group is a problem, since, at this time, it is rather homogeneous. Some differences undoubtedly occur in the excretory systems, but, as a rule, the systems have not been determined for the species. Fischthal (1951) notes that *C. micromyae* possesses an excretory system of the stenostoma type. The apparent direction of evolution of the group is toward a reduction in the amount of tail. Thus, *C. filicauda* is considered by Fischthal to be the most primitive. There may be a concomitant reduction in the number of cephalic glands and body size since *C. filicauda* possesses 11 pairs and most of the other species possess that number or less and are smaller. Species which are similar in other respects are separated by the occurrence of sensory papillae. Admittedly, there is little evidence to show phylogeny in this group; therefore, the lumping of *C. catatonki*,

C. honeyi, *C. micromyae*, and *C. pyriformis* together, and indicating that they originated from a common stem, as did Fischthal (1951) is highly speculative.

The macrocercariae as a group show a very diverse development of the tail, and at least two main modifications of the excretory system. The group may be characterized as follows:

1. The cercariae develop in sporocysts located in the gills of sphaeriid bivalves or in the viscera of unionids.
2. A stylet is present.
3. The differentiation of the reproduction system has developed to different levels in the various species.
4. The tail is inactive in a few species, but active or natatory in most.
5. There are cystogenous glands around the bladder.
6. Encystment occurs in a second intermediate host.
7. The excretory systems are of both the stenostoma and mesostoma types.

In view of the evidence present at this time, any plan of phylogeny can be only tentative. Fischthal (1951) suggested that the tail is the only apparent structure which can be used to show phylogeny in this group; however, it is my opinion that the excretory system should be considered as well. This would change Fischthal's concept of the phylogeny little. Goodchild (1943) suggested that the conclusions drawn from our information on the excretory systems would be questionable.

The macrocercariae which might be considered to be the most primitive are those which possess the *Gorgodera*-*Catoptroides* type of excretory system. *C. Gorgodera amplicava*, *C. G. cygnoides*, and *C. G. varsoviensis* are species which have been described with this type of excretory system. The cercaria of *Gorgoderina attenuata* is very similar in most respects to *C. Gorgodera amplicava*, but the great difference in excretory systems precludes the possibility of close relationships. It is held that a reduction in the tail has taken place in these cercariae; thus, on the structure of the tail alone, this species could be considered primitive.

The mesostoma type of excretory system, characteristic of the *Gorgoderina*-*Phyllodistomum* group, might be considered a more specialized one. The bifurcation of the primary excretory ducts here occurs anterior to the acetabulum in the region of the bifurcation of the intestinal tract, and there is no reflection posteriorly by the main collecting ducts. The main parts of the excretory system have been determined for three of the four species found in this group: *C. sphaerocerca*, *C. donecerca*, *C. coelocerca*, *C. phyllodistomum solidum*. The excretory formula has been determined only for *C. donecerca* ($2[(4)+(4+4+4)]$). On the basis of a similar tail, *C. coelocerca* is added to this group, although the excretory system is unknown.

C. sphaerocerca could be considered to be the most primitive member of this group on the basis of the less specialized tail. In this species, the tail is divided into three typical sections: cercarial chamber, proximal swollen part, and a distal tapered portion. Apparently, although the distome sometimes encysts in it, the chamber does not completely house the body, and it is probable that a second intermediate host is required.

The other three cercariae, *C. coelocerca*, *C. donecerca*, and *C. Phyllodistomum solidum*, are very similar, all three possessing natatory tails, and two possessing excretory systems of essentially the same nature. These cercariae are

completely enclosed in the cercarial chamber behind which is a slightly swollen portion of the tail. The degree of differentiation of the reproductive system is still at the level found in *C. eriensis*, and there is no apparent way to determine which of these species might be more highly evolved.

Slightly more advanced, on the basis of tail reduction alone, are *C. raiauda* and *C. steelmani*. In these very similar species, the entire anterior end, including the cercarial chamber of the tail, is grossly swollen. These cercariae are natatory, and the reproductive system is at the level of the group discussed above. Until the excretory system has been determined, these forms can be placed only tentatively in phylogeny.

Gorgoderina attenuata has an excretory system in which the bifurcation of the primary ducts occurs just posterior to the acetabulum. It is postulated that this type is more advanced than the type in which the bifurcation is anterior to the acetabulum. There has been a convergence in evolution of the tail of this species with that of *C. Gorgoderia amplicava*; the two appear almost identical. Nevertheless, if we can place any weight on the type of excretory system, these species are not closely related.

The cercariae of *Gorgoderina vitelliloba* and *G. pagenstecheri* are similar and the reproductive systems are at a higher degree of differentiation than those of the other macrocercariae. On the basis of the excretory systems and reproductive systems, these species appear highly evolved. However, the two are quite different; *G. vitelliloba* is placed alone on the basis of adult structures (Sinitsin, 1905).

The scheme of phylogeny (fig. 11) is intended to give a general concept of the relationships of the gorgoderid cercariae as they are conceived by this author and Fischthal (1951). Although the cercariae are listed in a series in some instances, it is not intended to give the impression of orthogenesis, but only suggesting general relationships.

With only a cursory observation of *C. lampsilae* and *C. eriensis*, the impression of likeness to some allocreadiid cercariae is inescapable. The tail, the excretory bladder, the cystogenous glands in the body, the excretory system, the sensory papillae—all are structures, the combination of which is very similar to that found in some allocreadiid cercariae. The gorgoderids here lack pharynges and eye spots; however, pharynges and eye spots are known elsewhere to be lacking in closely related species. Therefore, on the basis of similar host groups and similar anatomy, it is suggested that the gorgoderids are related to certain allocreadiids. Further investigation of these poorly defined families (Allocreadiidae and Gorgoderidae) is certain to change these categories and to indicate further suprafamilial relationships.

SUMMARY

Cercaria lampsilae, a macrocercous form, has been described as a trematode parasite in the viscera of mussels from Lake Erie, Ottawa County, Ohio.

Three metacercariae, belonging to the family Gorgoderidae, have been described as encysted in the viscera of Lake Erie mussels.

The metacercaria of *C. eriensis* has been found to occur naturally and has been traced experimentally to encystment in *Ligumia nasuta*, *L. recta*, *Ambelma costata*, *Lampsilis siliquioidea*, *L. ventricosa*, and *Elliptio dilatatus*.

The development and encystment of the metacercariae of *Cercaria lampsilae*

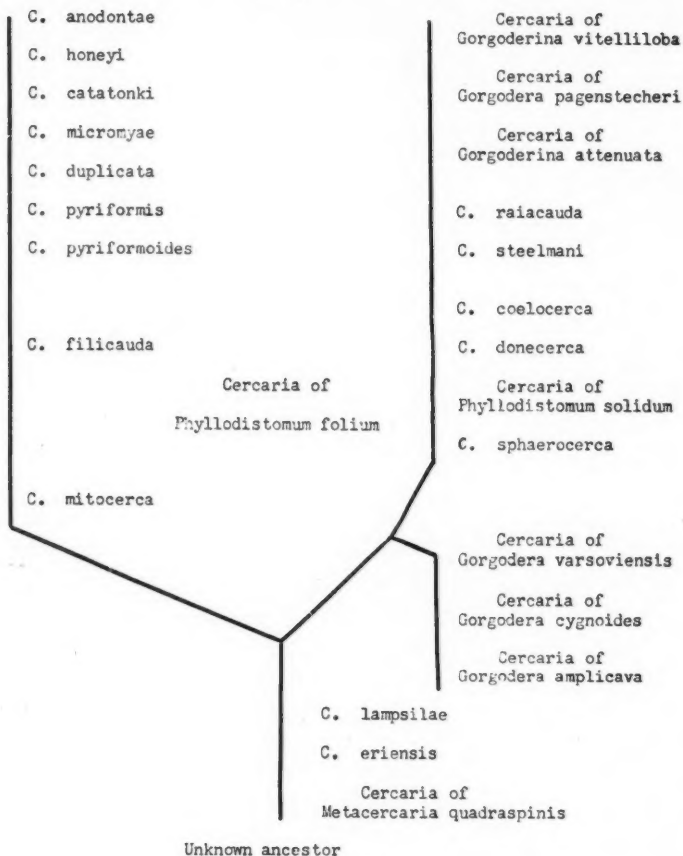


Fig. 11.—Possible phylogeny of gorgoderid cercariae.

have been followed experimentally in the mussel, *Lampsilis siliquoidea*. Natural infections were found in *Ligumia nasuta*, *L. recta*, and *Lampsilis ventricosa*.

The metacercaria of a new gorgoderid, tentatively named for this study *Metacercaria quadraspinis*, was found encysted in *Ligumia nasuta*. This species is clearly different from other gorgoderids by the presence of large spines dorsal to the oral sucker.

The excretory systems for *C. eriensis* and *C. lampsilae* have been determined and found to be new for the Gorgoderinae. The flame cell formula for *C. eriensis* is $2[(12+12+12)+(12+12+6)]$; and for *C. lampsilae* it is $2[(11+14+12)+(12+12+14)]$. A discussion is given concerning the evolution of gorgoderid cercariae.

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ADDENDA

From personal communication with Sewell Hopkins, it was learned that he had found a worm similar to *M. quadraspinis* which is described briefly in this paper. Having found between 60 and 70 distomes, he was able to gain important information concerning this form. The excretory pattern was given as "somewhere near $2[(7+7) + (7+7+7)]$." Furthermore, evidence was found which supports views expressed in this paper. The primary collecting ducts reflex in the region of the esophagus. Stylets were found in the cystic fluid indicating that styleted cercariae, perhaps similar to *C. eriensis* and *C. lampsilae*, give rise to these metacercariae. The excretory pattern is similar, but lacking a single pair of accessory collecting ducts, to the patterns reported by the author.

Sewell Hopkins reports that second intermediate hosts for these forms are *Lampsilis tampicoensis berlandieri* from the Little Brazos River near Bryan, Texas and *Musculium ferrissi* Sterki collected from the Navasota River near Navasota, Texas.

ABBREVIATIONS IN FIGURES

A—acetabulum	H—hooks
AG—primordia of genital ducts	I—intestine
AC—accessory collecting ducts	M—vagina
AMC—anterior main collecting ducts	NC—nuclei of cystogenous glands
AO—primordium of ovary	O—ovary
AT—fundaments of testes	OD—oviduct
AP—primordium of terminal genitalia	OS—oral sucker
CC—common collecting ducts	PMC—posterior main collecting duct
DP—ducts of penetration glands	SP—sensory papilla
E—esophagus	T—testis
EB—excretory bladder	V—vitellarium
EP—excretory pore	VE—vas efferens
GP—genital pore	

Sponge Spicules From the Lower Mississippian of Indiana and Kentucky

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Siliceous sponge spicules belonging to the genus *Hyalostelia* have been found at several localities along the strike outcrop of Lower Mississippian Borden group Floyds Knob-Edwardsville reef facies rocks from northern Indiana into Kentucky. It is believed that the presence of this unique form of spicule can be useful to recognize and trace the reef facies of this stratigraphic unit in both surface outcrops and subsurface samples.

Shrock and Malott (1929, p. 222) described the stratigraphy of a quarry 5 miles south of Wolcott, Indiana. On the basis of a few fragmentary fossils observed, they erroneously correlated the strata with the Devonian. This error has been subsequently corrected on a later edition (1932) of the *Geological Map of Indiana*. A visit to the quarry in 1951 yielded the first spicules recovered from HCl residues made from the several limestone samples collected. Little attention was given to these few fragmental spicules until later, when an examination was made of a Borden reef being quarried near New Ross, Indiana. At this place the rock consists of a coarsely-crystalline crinoidal limestone irregularly interbedded with bright, light grayish-green shale. The similarity of the crinoidal rock to that in the Wolcott quarry prompted a study of residues which yielded anchor-shaped spicules identical with those found in the Wolcott quarry. Later, a cursory stop to examine rocks in the roadcut section where U. S. highway 31 W ascends the Muldraugh Hill escarpment in Kentucky revealed the same crinoidal facies and spicules. Finally, samples furnished by the Indiana Geological Survey from the Floyds Knob formation of the Stobo bioherm east of Bloomington, Indiana, also contained *Hyalostelia* spicules.

In 1888, Hinde, pp. 158-162, identified two species of *Hyalostelia* (*H. smithii* and *H. parallela*) from the Lower Carboniferous rocks of England, Scotland, and Ireland. Ulrich (1890, p. 246, figs. 2-3) erected the species *Hyalostelia delicatula* for hexactinellid spicules found in Lower Pennsylvanian rocks of Illinois. Butts (1915, p. 159) mentioned white needle-like sponge spicules in the Borden rocks of the Muldraugh Hill area in Kentucky but did not describe them. Weller (1930, p. 242) described a sponge spicule assemblage including *Hyalostelia diabola* and *Hexactinellida delicatula* (Ulrich) from Lower Pennsylvanian rocks of Illinois apparently from the same horizon as the ones which Ulrich figured. Both Ulrich and Weller found large cylindrical shafts which undoubtedly came from spicules of the anchor type, but neither found the four recurved rays which are attached to these shafts in complete spicules. Some spicules described by Scott (1943) from the Lower Pennsylvanian of Montana appear to belong to *Hyalostelia* sp. namely the hexactinellids on plate 3 and the anchor spicules on plate 4, especially fig. 23.

STRATIGRAPHY

Stockdale (1931, 1932, and 1939) has worked out the regional stratigraphy of the Lower Mississippian rocks of Indiana and adjoining states. He also

has emphasized the importance of the Floyds Knob formation as a critical key unit and has recognized the great stratigraphic variation in Floyds Knob-Edwardsville strata produced by bioherms. His correlations, taken from Weller et al. (1948) are indicated in fig. 1. Stockdale correlates the crinoidal limestone in the base of the Muldraugh formation of Kentucky with the Edwardsville formation in Indiana. He states that the famous "crinoid beds" at Crawfordsville, Indiana, which are just 12 miles northwest of the New Ross quarry, are a bioherm built up from the Floyds Knob horizon and therefore equivalent to the lower part of the Edwardsville division. It would seem that in the areas of biohermal development where the reefs start within the Floyds Knob and continue into the Edwardsville, that the separation between the two formations would be hard to distinguish where only the reef facies is exposed.

Patton (1949, pp. 6-7) recognizes the rock being quarried near New Ross as Borden reef limestone but says that exposures are insufficient to reveal its exact position within the group though it probably is both Floyds Knob and lower Edwardsville. Samples provided by Patton from the Stobo reef are labelled Floyds Knob limestone and contain anchor-shaped spicules.

It is interesting to compare the stratigraphic position of the Borden spicules with those described by Hinde. The latter's material comes from Carboniferous limestones including the Yoredale series which Bond (1950) correlates with the D₂ zone in England. Cooper (1948, p. 354) matches this with the Meramecian-Ste. Genevieve interval in North America which is younger in age than the Borden forms. Hinde also collected specimens from Carboniferous limestones of Clitheroe which would be correlated with the C₁-C₂ zones of England, corresponding to Osagian-Meramecian Keokuk-Warsaw equivalents in this country. The C₁ zone may be reliably correlated with the upper part of the Osage Borden group.

The spicules described in this paper were found in light-gray, coarsely-crystalline crinoidal, detrital reef limestone. The fresh rock contains many



			Kentucky	Indiana	
MISSISSIPPIAN	LOWER	U.	Warsaw ls.	Harrodsburg ls.	
		OSAGE	Muldraugh fm.	BORDEN GROUP	Edwardsville fm.
			Floyds Knob fm. 		Floyds Knob fm. 
			Brodhead fm.		Carwood fm.
		K.	New Providence sh.		Locust Point fm.
					New Providence sh.

Fig. 1.—Correlation of strata containing spicules of the anchor type whose appearance is indicated in the right-hand column

white crinoid fragments which are partly or wholly siliceous and generally form nodules and stringers of chert. The bedding is wavy, irregular and discontinuous due to interbedded light gray-green clay shale. Beds range from a few inches to 18 inches in thickness though most are from 4 to 8 inches.



Fig. 2.—Distribution of surface outcrops of the Borden group of rocks in Indiana, showing the locations from which the sponge spicules were collected.

The rock weathers tan to light rusty-brown with white silicified nodules and fossils standing in relief. A typical fauna, such as is well represented at the New Ross quarry, Locality 2, includes an abundance of crinoid stem segments associated with a few calices transformed to geodes, many large spiriferid brachiopods, sponge spicules in abundance, and a few gastropods, cup and compound corals, and bryozoans.

Samples of the limestone and its fauna described above were all treated with concentrated HCl and washed clean. Residues consist predominantly of silicified crinoid stem segments the largest more than one inch diameter, crinoid plates and fragments, much white beekitized and skeletal silica, pale gray-green clay or shale particles, marcasite, pyrite, and numerous siliceous sponge spicules and spicule fragments. Millerite is also present in some of the geodes at Locality 2.

LIST OF LOCALITIES

1. Quarry 5 miles south of Wolcott, White County, Indiana. The quarry is in the extreme southwestern corner of section 19, T. 26 N., R. 5 W. Shrock and Malott give the following section:

Top of quarry	Thickness
Bed 6. Light pink to gray, thin-bedded, coarsely-crystalline limestone	6' 0"
Bed 5. Blue to gray sandy shale	1' 6"
Bed 4. Thin-bedded gray limestone	1' 0"
Bed 3. Blue to gray sandy shale	1' 6"
Bed 2. Thin-bedded, gray crystalline limestone with occasional chert nodules	5' 0"
Bed 1. Light gray crystalline limestone with some chert	1' 6"
Bottom of quarry. Total exposed	16' 6"

Since the quarry has been abandoned and filled with water, only the top unit, bed 6, is exposed; consequently spicules are from this bed. The entire section described suggests crinoid crystalline reef facies interbedded with thin shales typical of the Borden group.

2. New Ross Limestone Company quarry in the NE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Section 3, T. 17 N., R. 3 W., about 1.5 miles southwest of New Ross, Montgomery County, Indiana. Patton (1949, p. 29) reports 13.6 feet of Borden reef being quarried with the upper part eroded. Rocks in the quarry contain an excellent Osage fauna of crinoids, brachiopods, gastropods, corals, bryozoans, and sponge spicules. This type of reef must be similar to the one removed from Crawfordsville, Indiana, whose beautifully preserved crinoids are world-famous.

3. Quarry in Stobo bioherm in the NE $\frac{1}{4}$ of the NE $\frac{1}{4}$ of Section 4, T. 8 N., R. 1 E., Monroe County, about 6.5 miles east of Bloomington, Indiana. Samples were supplied by Ned Smith through John Patton of the Indiana Geological Survey. They come from the Floyds Knob limestone, 3.2 to 8.2 feet above the base of the quarry, and all contain anchor-shaped spicules.

4. Roadcut section east side of U. S. highway 31W along the base of Muldraugh's Hill escarpment in Hardin County, Kentucky. The section can be located on the Vine Grove quadrangle, Kentucky topographic map, 1946 edition issued by the Army Engineers Corp. On this map the section is located 1 $\frac{1}{8}$ inches east and 2 $\frac{3}{8}$ inches south of the northwest corner of the quadrangle.

There is 15 to 16 feet of coarsely-crystalline crinoidal limestone interbedded with green clay overlain by bluish-gray silty shale containing vermicular markings. The contact between the two is shaly and weathers out rapidly making the separation very conspicuous. Stockdale assigns these two units to the Muldraugh formation.

SYSTEMATIC DESCRIPTION

Phylum PORIFERA

Class HEXACTINELLIDA (*Hyalospongia*)

Order LYSSACINA

Family POLLAKIDAE Marshall

Genus HYALOSTELIA Zittel 1878

Weller (1930, p. 242) outlines the characteristics of the genus as follows:

"These fossil sponges are known principally from detached spicules, and are composed partly of simple hexactinellid spicules, one axis of which is commonly much elongated, and partly of spicules one or more rays of which are inflated, spined, reduced to rounded knobs or even absent. The sponges were anchored to the bottom by a root-tuft composed of elongated spicules which are not uncommonly observed to terminate in four recurved rays."

"It has been customary for paleontologists to refer Paleozoic hexactinellid spicules which are accompanied by fragmentary root tufts to the genus *Hyalostellia* (sic). It appears to me that the possession of a root-tuft is not a generic character, since many varieties of modern forms are anchored by such a structure, and I prefer to restrict *Hyalostellia* to include only those forms which are at least composed of hexactinellids with one or more inflated rays."

In the studies of Hinde, Ulrich, Weller, and the present one, hexactinellid spicules are associated with anchor-shaped forms and vice versa. Ulrich and Weller have assigned separate species names to the different types of spicules. The association, type of preservation, color, and robust character of both types of spicules leads me to believe that they belonged to the same species.

The problem of classifying separate spicules of sponges is difficult indeed and in the absence of the entire body it is impossible to apply a natural zoological classification. Recognizing, as Hinde did, that the genus *Hyalostelia* consists of dermal, body and anchor spicular elements of varying sizes and shapes, I have been compelled to place all the spicules from the Borden reefs in a single species. Following Scott (1943) each of the characteristic spicule types is then given a form name under this species. This designation is expedient in the absence of positive proof of the biological affinities of the spicules.

Hyalostelia ancora n. sp.

Pl. 1, figs. 1-28

Diagnosis.—The entire form of the sponge is unknown. The portions preserved are detached skeletal spicules of various forms and dimensions representing both body and anchoring appendage. The specimens illustrated have been selected from over 600 spicules obtained from the four localities. Anchor-shaped spicules are termed anatetraene, but six-rayed spicules are referred to as hexactinellid and oxyaster.

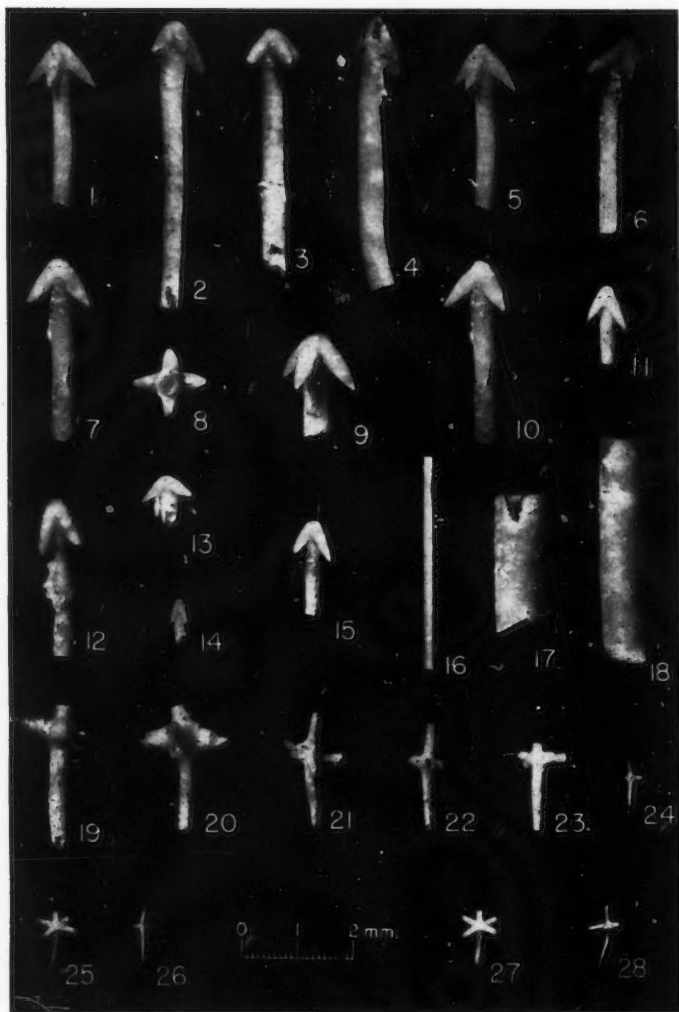
ANATETRAENE FORM

Pl. 1, figs. 1-18

The idealized spicule of this type is illustrated in fig. 3, which also shows the statistical parameters that can be designated and measured. The spicule consists of a cylindrical shaft terminated by four recurved rays or clads. Since the anatetraene form is the dominant one in my collection, I have chosen a single spicule of this type as holotype of the species, pl. 1, figs. 1, 5. This particular well-preserved spicule has a length of 3 mm. The dome angle is approximately 70° and subtends a chord of 1.27 mm. The sagittal distance is .8 to .85 mm and the shaft thickness .35 mm. The length of each clad has a clad angle of 29°. The apex of the cladome is more sharply rounded than in some other specimens.

There is quite a bit of variation in the size and shape among the more than 300 specimens of anatetraenes at my disposal. The variation in dome angle is the most conspicuous feature, as shown in pl. 1, figs. 1 and 14, between 70° and 10° respectively. Generally this angle is in proportion to the size of the spicule, for mature spicules have an angle which varies between 60° to 80° though young ones are less than 30°. Another variable feature is the shape of termination of the clads. The extremes are illustrated in pl. 1, figs. 3 and 5; the former shows clads with almost rounded terminations but in the latter they

PLATE I



Figs. 1-28. Spicules of *Hyalostelia ancora* n. sp.—1-18. Anatetraene forms; 1, 5. Stereogram of holotype, loc. 4; 2, 4, 6, 8-9, 11-15. Single views, all from loc. 4 except fig. 11 which is from loc. 2; 7, 10. Stereogram, loc. 4. 19-28. Hexactinellid and oxyaster forms; 19, 20. Hexactinellid forms, loc. 4; 21-23. Intermediate forms, loc. 4; 24, 26, 28. Oxyaster forms, 24 is from loc. 4, 26 and 28 from loc. 2; 25, 27. Stereogram of intermediate form, loc. 2.

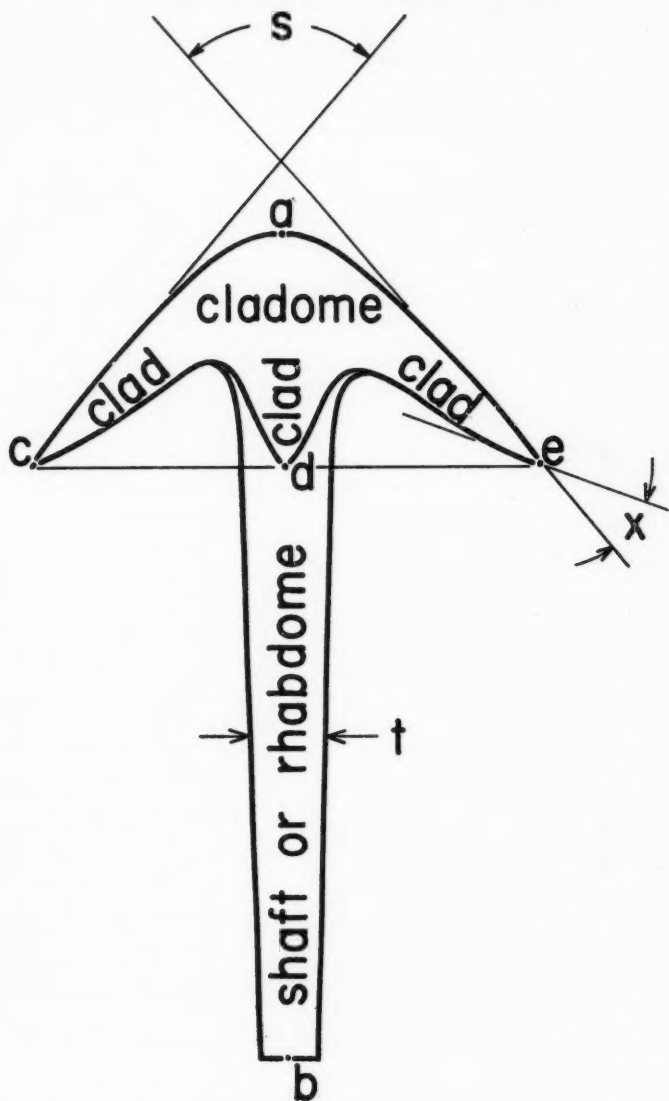


Fig. 3.—General sketch of anatetraene spicule showing component parts. Modified after Scott (1943). a—apex, a-b—length of spicule, c-e—chord, a-d—sagitta, t—thickness of shaft, s—dome angle, x—clad angle, a-c—length of clad.

are very acutely pointed. There also is wide variation in size. Although all spicules of this type have their shafts broken, the longest spicule recovered is 5.13 mm in length (pl. 1, fig. 2) and the greatest diameter of shaft is .9 mm (pl. 1, fig. 17). Most shafts are cylindrical and of uniform diameter but some are irregular and taper slightly. The spicules have a light tan color and are preserved of chalcedonic silica giving them a translucent horny aspect. As a rule the axial canals are abnormally large (pl. 1, fig. 8).

HEXACTINELLID FORM

Spicules in which the six stout cylindrical rays radiate from a common center, the vertical rays being longer than the transverse. Spicules are characteristically robust, with rays whose diameters remain essentially constant and terminate abruptly or bluntly in contrast to the oxyasters, which have tapering rays. The spicules of this form are relatively simple and typical examples are shown on pl. 1, figs. 19, 20. While the rays are broken off, the length along the vertical axis is 2.5 mm with a diameter about .25 to .30 mm. The color, preservation, and enlarged axial canals are the same as for the anactinaes.

OXYASTER FORM

This type is a simple six-rayed form with the vertical axis longer than the transverse rays. It differs from the hexactinellid form described above in that the spicules are smaller and the rays taper distally. The spicules are whiter than the others, plain, smooth, and commonly have curved rays. In its general characteristics this form might very well fall within the variations of the species which Weller describes as *Hexactinellida delicatula* (Ulrich). Typical specimens are shown in plate 1, figs. 24, 26, and 28. Their length is about 1 mm and the diameter of rays is .1 mm or less. Variations between forms have some of the characteristics of both hexactinellid and oxyaster (plate 1, figs. 21-23, 25).

Remarks.—The diversity of spicules may mean that more than one species is present, but this cannot be demonstrated with the material at hand. Since a holotype is chosen, other types may be removed from *H. ancora* if they prove to be different.

Hyalostelia ancora consists of regular hexactinellids and spicular rods belonging to the anchoring appendage. In this respect, and in the general appearance of the spicules, it closely resembles *H. parallela* and especially *H. smithii*. It lacks the modified hexactinellid 5-rayed dermal spicules described by Hinde, as well as the hexactinellid spicules with one or more inflated rays which Hinde also mentioned and which Weller makes typical of the genus. Of course, for that matter neither Ulrich nor Weller actually found any anchor spicules except the broken shafts which presumably came from such spicules. In addition to these differences, the anchor spicules of *H. ancora* are more uniform in their recurved shape and have smaller shafts than *H. smithii*, which they otherwise resemble.

The abundance of siliceous spicules in the residues of these Lower Mississippian biohermal limestones indicates that sponges must have played a significant part in the ecology of the reef. This study which recognizes the affinity of sponge remains to reef facies traces this reef development as far north as the quarry 5 miles south of Wolcott, Indiana.

I agree with Martin (1931) who discusses the origin of silica in Mississippian limestones of Indiana when he concludes that the siliceous sponges are the source of much of the chert and silicification within these limestones.

Types.—Both holotype and figured specimens will be deposited with the U. S. National Museum.

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Notes and Discussion

Sizes of Wood Cuttings Handled by Beavers

Felling the trees which they use as food and building material, is only the first in a series of operations which the beavers must carry out, for they must dismember them and transport the pieces or sections to the location where the material will be used. When the smaller limbs and twigs are gnawed off, the beaver seizes them with his incisor teeth and draws or tows them to his dam or lodge. The larger limbs and even the bole of the smaller trees are cut into lengths according to their diameters, their weights, and the beaver's ability to handle the sections cut.

The literature contains numerous specific statements concerning the diameters of trees felled by beavers, and occasionally a general statement is found giving the approximate sizes of some cuttings. No specific study or analysis seems to have been made to determine the larger diameters and the longer lengths of the cuttings handled by beavers in their dam and lodge constructions. In August 1951 an opportunity to make such measurements furnished the data for this paper, and it is hoped that others may be stimulated to gather additional data from other areas. Eventually these accumulated data would be sufficient to make possible valuable comparisons of beaver work, in different areas, under different conditions, thus giving us a much better understanding of this phase of beaver work.

Through the kindness and cooperation of the Allegheny State Park Commission of Red House, New York, the author has for many years enjoyed the opportunity of studying the native animals and carrying on research in the 65,000 acre park area.

Procedure.—The cuttings studied were from a beaver dam on France Brook which has been occupied by an active beaver colony for over ten years.

The dam studied is 476 feet long and varies from a height of six feet, at the southeast angle, to a few inches at both its east and its west ends. Each year the dam has been repaired and usually some new cuttings have been added to it. Since the dam is several years old, many of the older and deeper cuttings are partly rotted or so deeply buried in the construction that no effort was made to dislodge them for measurement. The few cuttings which had to be dislodged from the dam were measured and immediately replaced in the dam as nearly as possible as they had been located and arranged previously. The measurements of the cuttings were made during August and early September 1951, all but six cuttings were a year or more old, and all of them were without the bark, except half a dozen soft maples from which the beavers had not used the bark for food.

In choosing the pieces of dam materials used for measurements, no attempt was made to measure all pieces used for, (1) that would have meant the unlawful destruction of the dam, (2) every effort was made to avoid damage or change in the dam structure by removing wood sections, and (3) the main interest was to get information particularly on the larger pieces (2 inches or more in diameter) and on the lengths of the longer sections rather than to get the length of all the sections.

The diameters to the nearest one eighth of an inch, taken with an outside calliper, were made at the base of the cutting. These measurements represented the diameter of the dry, seasoned, barkless logs, i.e. minimum diameters, as compared to the diameters including the green bark present when the cuttings were first harvested and handled, i.e. the maximum diameters. The green bark had been used for food, after which the peeled wood sections were used for dam and lodge construction. The length of each cutting and the kind of wood were also determined. After all of these data were entered on the data sheet, the log was immediately marked by an axe blaze to indicate that the data had been taken and recorded.

Trees represented.—Four woods made up the general bulk of the larger cuttings found in this dam, and the distribution of the 140 cuttings studied was as follows: 92 pieces (65.7%) poplar (*Populus tremuloides* and *grandidentata*), 21 pieces (15%) blue beech (*Carpinus caroliniana*), 16 pieces (11.4%) were shadbush (*Amelanchier canadensis*) and 10 pieces (7%) were maple (*Acer*) in which sugar, red, and silver maples were represented. One fair sized elm (*Ulmus* sp.) was observed.

The considerable use of both blue beech, and shadbush, has been characteristic of the work of beavers in the Allegheny State Park area. Shadle and Austin (1939, Jour. Mamm. 20(3):299-303) pointed out that a beaver colony in the upper Quaker Run area

† Largest diameter of cutting of each kind of wood.

Where beavers have cut up a felled tree, it is quite evident from the location of the individual piles of chips which mark the successive sections into which the tree has been cut, that with the increase in the diameter of the successive cuts, the lengths into which the sections are cut are more or less progressively shorter. Through the kindness of Miss Mabel Montgomery of the Department of Mathematics a study of the measurements of the cuttings produced a chart which gave further definite corroboration of the general trend from long cuttings of small diameters through progressively shorter cuttings as the diameters of the sections of wood cut increased in size.

Measurements.—The longest piece handled by the beavers was a 247 inch sugar maple (*Acer saccharophorum*), 2.16 inches in diameter at the base. The longest aspen (*Populus* sp.) section measured 161 inches and was 3.75 inches in diameter. The longest blue beech (*Carpinus caroliniana*) was 115 inches long and 3 inches in diameter. A three and one half inch shadbush (*Amelanchier canadensis*) log was 118 inches long. The single large elm (*Ulmus* sp.) found, was a 122 inch log, 3.75 inches in diameter.

The largest diameter 6.37 inches was that of an aspen log 42 inches long. The largest shadbush 5.75 inches in diameter was 82 inches long; a 5 inch blue beech 77 inches long, and a 4.75 inch maple (*Acer* sp.) log 138 inches in length were the two largest cuttings of these last two kinds of wood.

The above figures were made from old, seasoned, barkless wood, and it would also be interesting to have measurements of the green cuttings, at the time they were made, and when they would show their maximum diameters and maximum weights. Such figures would also give a more adequate idea of the ability of the beavers in handling large sized and heavy cuttings.

Measurements of the weights of the heavy cuttings handled by the beavers and also measurements of the work expended by the animal in dragging these pieces would furnish interesting additional data which could be readily obtained.—ALBERT R. SHADLE, University of Buffalo, Buffalo, N. Y.

A Bloom of Nauplius Larvae

Bodies of freshwater occasionally give rise to a bloom of a particular organism which suddenly appears in very great abundance. Under certain favorable conditions a species will attain an abundance far beyond its normal density which cannot be maintained for long. Algal blooms are well known. On March 17, 1951, the writer encountered a bloom of nauplius larvae in a temporary pool while collecting phyllopod Crustacea. The water was murky with the swarming larvae. The collecting net in a single dip was completely coated with a scum of countless larvae. The older stages indicated they were larvae of copepods. The pool is a shallow (maximum depth of 2.5 ft. at the time) pasture pool near Brimfield in Portage County, Ohio. The temperature was 7.0° C and the pH 5.9. This was the only observation of such a bloom in this pond over a period of three years during which visits were made each week while water was present.—RALPH W. DEXTER, Kent State University, Kent, Ohio.



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